The Impact of an Intervention and Policy Changes on Emergency Department Utilization

BY

SARA HEINERT
B.A., University of Rochester, 2006
M.P.H., University of Michigan, Ann Arbor, 2008

THESIS

Submitted as partial fulfillment of the requirements for the degree of Doctor of Philosophy in Public Health Sciences (Health Policy and Administration) in the Graduate College of the University of Illinois at Chicago, 2018

Chicago, Illinois

Defense Committee:
- Lisa Powell, Chair and Advisor
- Amit Arwindekar, Emergency Medicine
- Zeynep Isgor, Health Policy and Administration
- Pierre Thomas Léger, Health Policy and Administration
- Terry L. Vanden Hoek, Emergency Medicine

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF FIGURES

FIGURE PAGE

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF ABBREVIATIONS

ACA	Affordable Care Act
ARRA	American Recovery and Reinvestment Act
CIA	Conditional Independence Assumption
DID	Difference-in-Differences
ED	Emergency Department
EMR	Electronic Medical Record
EPIC	Emergency Patient Interdisciplinary Care
ESI	Emergency Severity Index
FQHC	Federally Qualified Health Center
ICD-9	International Classification of Diseases, Ninth Revision
ICD-10	International Classification of Diseases, Tenth Revision
MRN	Medical Record Number
NAMCS	National Ambulatory Medical Care Survey
NE	Non-Emergent
NEPCT	Non-Emergent + Primary Care Treatable
NHAMCS	National Hospital Ambulatory Medical Care Survey
NYU	New York University
PCP	Primary Care Provider
PCT	Primary Care Treatable
RCT	Randomized Controlled Trial
SD	Standard Deviation
SES	Socioeconomic Status
UDS	Uniform Data System
UI	University of Illinois

SUMMARY

This thesis was composed of three studies, which looked at the impact of one intervention and two policy changes on emergency department (ED) utilization at University of Illinois (UI) Hospital in Chicago, Illinois.

The first study, Chapter I, evaluated an individualized care coordination intervention program for frequent visitors of the emergency department. Frequent emergency department (ED) visitors - generally defined as having three to five visits in one year (Billings and Raven, 2013; Byrne et al., 2003) - make up 2.6-6.1% of all patients seen in the ED but account for 10.5-26.2% of all visits. (Jiang et al., 2017) The Emergency Patient Interdisciplinary Care (EPIC) program aimed to improve efficient usage of healthcare resources by teaching frequent ED visitors how to better manage their health, and connect them to providers outside of the ED (primary care and specialty physicians) and other available resources (such as insurance, transportation, housing) through an individualized care coordination program.

The purpose of this study was to determine the effect of the EPIC program for frequent ED visitors at University of Illinois (UI) Hospital on ED, outpatient, and inpatient visits at the UI Hospital system. Additionally, we analyzed if intensity of program intervention resulted in differing levels of change. The goal of the EPIC program was to promote effective use of healthcare services. While we hypothesized that the EPIC program would achieve its goal of decreasing ED utilization and increasing outpatient utilization due to better coordination of care, we also realized the possibility of other unintended consequences. For example, we did not know if providing more attention to these ED frequent visitors would increase, decrease, or not change their use of the ED. This study was important because inefficient healthcare usage is

costly. In 2012, the average cost of a community health center visit ($150) was less than one-sixth the average cost of an ED visit ($978). (National Association of Community Health Centers, 2015)

The research design for this study was propensity score matching of the intervention group to a comparison group of similar ED frequent visitors, followed by a difference-in-differences analysis of the matched pairs. Overall, there was a significant increase in ED visits from before EPIC started to after EPIC for the intervention group, compared to the comparison group, for both post-period time frames. These findings differed from the intended goal of the program, which was for the EPIC intervention to decrease ED visits and increase outpatient visits. Instead, the intervention increased ED visits and did not affect inpatient or outpatient utilization.

We also analyzed the data by intervention intensity groups and found that there were increased ED visits in the post-period compared to the matched comparison group for most intervention intensity groups. The magnitude of the increase in ED visits grew as the intensity of the intervention increased. Patients with more interactions with the EPIC team may have felt more connected to the ED than those with less interactions, resulting in preferences for the UI Hospital ED over others. The exception to this finding is the results of the highest intensity group, which saw no significant change in ED visits.

The indication that program participants increased ED utilization after the program, compared to comparison patients was a new finding in this field. Future studies with strong analytical methods are warranted to determine if there is replication of this finding in other studies. This study exhibits the importance of including a comparison group and having access to data that covers a larger geographical area than only one hospital in order to truly see the effect of the program on its participants. It was possible that program participants may have felt more comfortable or satisfied with their care in the ED because of the program, and future programs that target frequent ED visitors but are physically located in an outpatient setting may be more likely to see a shift in utilization from the ED to the outpatient setting. Patients who frequented multiple EDs before the program may have consolidated their care to only the UI Hospital ED after participation in the program. As a result, obtaining data that provides visits for all patients across all sites of care would be a necessary next step to determining if our interpretation of these findings is accurate.

The second study, Chapter II, explored the association between distance to closest federally qualified health center (FQHC) and Medicaid and uninsured patients' utilization of the ED of UI Hospital for non-urgent health care needs. After the economic recession of 2008, the American Recovery and Reinvestment Act (ARRA) of 2009 allocated two billion dollars for FQHCs, including $155 million in funding for 126 new access points (NAP) for health centers. (Shin et al., 2010) From February 2009 to July 2011, the number of full-time FQHCs in the 9 miles surrounding UI Hospital increased from 95 to 124.

The purpose of this analysis was to explore the impact of being closer to a FQHC on non-urgent ED utilization of UI Hospital ED patients and within patient changes in distance that occurred during the bulk of FQHC openings from ARRA (February 2009 to July 2011). We hypothesized that people who had a change in distance to the closest FQHC would have a decreased proportion of non-urgent ED visits due to the opening of a new FQHC that is closer. Using ArcGIS mapping of patient homes and FQHC locations, we determined the distance to the closest FQHC for each month that the patient presented to the ED. Since we were limited to data that only included patients of the UI Hospital ED, we did not know if there were other sites that patients may have gone for health care needs such as FQHCs and other hospitals' EDs, so this study was exploratory.

We used patient fixed effect linear regression models to look at the data within patients and pooled cross-sectional models to look at the data across patients. The outcomes of interest were the proportion of non-emergent (NE), primary care treatable (PCT), and non-emergent+primary care treatable (NEPCT) ED visits using the NYU Algorithm developed by Billings et al. (2000). We also looked at the Emergency Severity Index (ESI) that patients are assigned by a nurse for the urgency of their condition.

Our findings suggested that a decrease in distance to the closest FQHC purely induced by a new FQHC opening near patients' residences between the period February 2009 and July 2011 was not associated with a change in non-urgent ED visits within our study's geographic coverage (i.e., within 9 miles surrounding of the UI Hospital ED) and during our study period. Given that we had no significant findings, there may be more complexities involved in the patient's decision to use the ED for care versus use a FQHC including quality. This study had many limitations and as a result should be considered exploratory. Future research that uses data that includes visits to multiple EDs and visits to FQHCs and other primary care settings utilized by this patient population would provide better evidence to determine if there is truly no relationship between FQHC distance and non-urgent ED utilization, as it would give the full extent of patients' health care utilization. Additionally, more data on specific characteristics of each FQHC, including services available (such as lab tests and imaging), operating days and hours (such as operation on the weekends), and quality indicators, could provide a better picture of patient preferences for using certain FQHC sites. Use of the ED for non-emergent issues is expensive, and further research is warranted to determine how to improve access to lower cost options such as FQHCs.

The purpose of the third study, Chapter III, was to determine if the proportion of non-urgent ED utilization changed at UI Hospital in after the Affordable Care Act (ACA) of 2010. Reforms of the Act included expansion of Medicaid eligibility (if determined by state), insurance premiums that were subsidized, incentives to provide health care benefits for businesses, and prohibiting insurers from denying coverage for pre-existing conditions. (Elmendorf, 2010) Illinois was one such Medicaid expansion states, so in January 2014, Illinois Medicaid expansion and the Health Insurance Marketplace Exchange both took effect, increasing health insurance coverage for the uninsured.

We hypothesized that initial non-urgent ED use would increase because insurance would relieve cost barriers but the newly insured may need time to connect to the outpatient setting and may have pressing health conditions so they may initially seek care in the ED. We hypothesized that longer term non-urgent ED use would decline because once primary and specialty care was established, we believed care would be received in an outpatient setting rather than the ED.

This study was significant because patients with non-urgent ED usage may be seen more efficiently (for less cost) in other health care venues. Patients arriving to the ED with private insurance and Medicaid may have been especially affected by the introduction of the Marketplace Exchange and Medicaid expansion, so the analysis explored changes by insurance type. Additionally, we assessed changes in non-urgent ED use based on whether or not the patient arrived to the ED during business hours. By determining which, if any, types of patients have changed the proportion of non-urgent ED usage after the introduction of the ACA, these groups can specifically be targeted for interventions.

The research design was interrupted time series- at the week level over the time period of interest (January 2012- May 2017), with the intervention being comparison of the time period before and after implementation of the ACA. The outcomes of interest were the proportion of non-emergent (NE), primary care treatable (PCT), and non-emergent+primary care treatable (NEPCT) ED visits using the NYU Algorithm developed by Billings et al. (2000). We also looked at the Emergency Severity Index (ESI) that patients are assigned by a nurse for the urgency of their condition.

Amongst all of our interrupted time series findings, all level changes after ACA were positive and all time trend changes after ACA were negative. This general pattern supported our hypothesis that initial non-urgent care would initially increase, and then decrease over time. This finding suggests that after ACA, newly insured patients were able to eventually connect to primary care, therefore decreasing the proportion of visits that were seen in the ED but could have been seen in a primary care setting.

However, significance of level and time trend changes varied by patient group. Looking at all patients overall, there were no level changes. There were negative time trend changes across most levels of PCT visits and one level of NEPCT visits, which might have been driven by the change in PCT visits. Since there were no significant level changes in the overall population, patients may have generally been able to connect to outpatient settings quickly and continuously after the start of the ACA, and the use of the ED for primary care treatable visits decreased over time.

In comparing Medicaid and private insurance patients, both subsets had positive level changes in NE and NEPCT ED visits after ACA. There were more significant positive level increases, with greater magnitudes, for Medicaid patients than other types of patients, and Medicaid patients had no significant negative time trends. Patients with private insurance may have been more likely to connect to primary care than Medicaid patients because of a greater out-of-pocket copay for them to use the ED compared to a doctor's office. For Illinois Medicaid patients, in 2018, the co-pay for an emergency room visit in a non-emergency and copay for a physician/clinic visit are both $3.90.(Illinois Department of Human Services, n.d.) While there are numerous private insurance plans, one private open access insurance plan for State of Illinois employees had a minimum $20 copay for a primary care visit to a doctor's office and a $250 copay for each ED visit.(State of Illinois, 2018) This large difference between the cost of a doctor's office visit versus an ED visit for private insurance patients, compared to no difference between the cost of these visits for a Medicaid patient may explain these findings. Another explanation is that Medicaid patients may have had a more difficult time finding outpatient doctors who accept Medicaid insurance, so it may have been a challenge to get an appointment with a doctor due to a lack of capacity.

We also looked at patients who arrived to the ED during business hours and found that these patients had significant positive level changes for NE visits and negative time trend for

PCT visits. Patients who arrived to the ED during business hours arrived when other alternatives for care, such as doctor's offices and clinics, were likely open at that time. These patients may have initially needed the ED for non-emergent needs while they connected themselves to outpatient care, at which time the time trend for their PCT visits decreased over time.

In looking at ESI, we found a significant negative level change in being assigned an ESI of 4 or 5 (least urgent) at arrival to the ED after ACA for patients with private insurance and those who arrived to the ED during business hours. These subsets of patients also had positive level changes for NE visits. This may suggest that, compared to before the ACA, these patients may have arrived to the ED with conditions that appeared more urgent at the start of the visit or required multiple resources or tests, which would have warranted a more urgent ESI value. Although patients presented with more severe-appearing conditions, they were more likely to eventually be diagnosed with conditions that were non-emergent.

Our findings had the longest post-expansion period (3 ½ years) of any other study we could find on the association between increased insurance coverage and non-urgent ED utilization, which may show a more complete picture of long and short-term effects of the ACA on non-urgent ED use. More research that expands the data to a wider reach of hospitals and outpatient sites, and includes a comparison group, would be beneficial to obtain causal findings.

I. EVALUATION OF AN INDIVIDUALIZED CARE COORDINATION INTERVENTION PROGRAM FOR FREQUENT VISITORS OF THE EMERGENCY DEPARTMENT

A. Introduction

Frequent emergency department (ED) visitors - generally defined as having three to five visits in one year (Billings and Raven, 2013; Byrne et al., 2003) - make up 2.6-6.1% of all patients seen in the ED but account for 10.5-26.2% of all visits. (Jiang et al., 2017) Frequent visitors to the ED may lack knowledge or access to social and medical resources that could shift their utilization of healthcare resources and ultimately improve their health. The Emergency Patient Interdisciplinary Care (EPIC) program aimed to improve efficient usage of healthcare resources by teaching frequent ED visitors how to better manage their health and connect them to providers outside of the ED (primary care and specialty physicians) and other available resources (such as insurance, transportation, housing) through an individualized care coordination program.

The purpose of this study was to determine the effect of the EPIC program for frequent ED visitors at University of Illinois (UI) Hospital on ED, outpatient, and inpatient visits at the UI Hospital system. Additionally, we analyzed if intensity of program intervention resulted in differing levels of change. The goal of the EPIC program was to promote effective use of healthcare services. While we hypothesized that the EPIC program would achieve its goal of decreasing ED utilization and increasing outpatient utilization due to better coordination of care, we also realized the possibility of other unintended consequences. For example, we did not know if providing more attention to these ED frequent visitors would increase, decrease, or not change their use of the ED. This study is important because inefficient healthcare usage is costly. In 2012, the average cost of a community health center visit ($150) was less than one-sixth the average cost of an ED visit ($978). (National Association of Community Health Centers, 2015) If this program is found to shift usage of healthcare services, away from the ED, individualized intervention programs like this could be an effective tool for better use of healthcare to decrease healthcare costs for frequent ED visitors.

B. Literature Review

Much literature has explored interventions for frequent ED visitors, with mixed results. But many studies have been weak, with very specific inclusion criteria for study participants, small sample size, and/or analysis issues.

Some frequent ED utilizer intervention programs have shown decreased ED utilization, however they targeted very specific inclusion criteria for study participants, which also tends to decrease the sample size and limit generalizability of results. These studies include intervention groups composed of 20 frequent visitors who were chronically homeless and alcohol-dependent (McCormack et al., 2013), a study of 36 low-income, uninsured high ED utilizers (Crane et al., 2012), and an intervention on 48 high ED users with psychiatric disorder (Abello et al., 2012). Other studies have specifically targeted only the highest risk groups that might be easier to see immediate change- such as uninsured individuals (Crane et al., 2012; DeHaven et al., 2012; Wetta-Hall, 2007), and very high ED utilizers such as those with 3-5+ ED visits in a month, 10+ visits in a year, or the top 100 patients with highest number of visits (Grover et al., 2010; Lee and Davenport, 2006; Pugh et al., 2010; Spillane et al., 1997; Stokes-Buzzelli et al., 2010).

Additionally, most studies on care coordination programs on ED frequent visitors have shown a decrease in ED utilization but have implemented weak analysis strategies that suggest correlation and not causation. Some studies have used descriptive analysis- comparing changes in number of ED visits or other outcomes before and after the program without controlling for patient characteristics. (Abello et al., 2012; Brandon and Chambers, 2003; Grover et al., 2010; Newton et al., 2011; Okin et al., 2000; Pillow et al., 2013; Pugh et al., 2010; Raven et al., 2011) Other studies have included covariates but have done so poorly, which could lead to biased estimates resulting from overall differences in the two groups, rather than any affect from the intervention itself. Studies have included covariates using step-wise procedures based on significant p-values- following an ad hoc approach rather than a theoretical or conceptual model (DeHaven et al., 2012), have not tested for differences between observable variables in intervention versus comparison groups (Enard and Ganelin, 2013), or do not mention matching on observable variables between the intervention and control groups (Shah et al., 2011). These methods lack theoretical support and are likely to lead to violations of conditions necessary for unbiased results. In observational studies without randomization, it is important to compare treatment and control groups that are balanced in a set of observed covariates. (Rosenbaum and Rubin, 1983) (More discussion on the conditions necessary for unbiased results can be found in the Propensity Score Matching section under Research Design). One study used a control group of matched nonparticipants who were eligible for the program but either declined or were unreachable for participation (Navratil-Strawn et al., 2014), suggesting a biased sample compared to those in the intervention group. In another study, patients were used as their own control. (Stokes-Buzzelli et al., 2010)

Two studies found no statistically significant reduction in ED visits as a result of a case management intervention, however they both had small sample sizes (N=50 and N=33)(Lee and Davenport, 2006; Spillane et al., 1997) and one did not include a comparison group in their analysis (Lee and Davenport, 2006).

Two recently published studies were randomized controlled trials (RCTs). Bell et al. (2015) looked at an intensive care management program intervention on a very specific study population- disabled Medicaid beneficiaries at risk for high future health care costs, with mental health and/or substance abuse problems. (Bell et al., 2015) Seaberg et al. (2017) studied a patient navigation intervention on patients with 5 or more ED visits in the past year. (Seaberg et al., 2017) Both studies were hampered by program participation of only 43-45% of individuals in the intervention group. As a result, authors of both studies analyzed their findings using intent to treat (ITT) analysis. Bell et al. found that the intervention group had higher prescription drug costs and higher odds of using outpatient mental health services than the controls. Seaberg et al. found that the intervention group had a greater decrease in ED visits and greater decrease in overall healthcare costs 1 year after program enrollment compared to the control group, as well as more primary care physician visits 1 year after program enrollment, although this variable was self-reported.

Due to the low program participation, Bell et al. decided to perform a sub-analysis of program participants using matching and difference-in-differences (DID) strategies. The sub-analysis showed that program participants (N=251) had fewer unplanned hospital admissions and lower associated costs, and lower odds of homelessness, but also had higher prescription drug costs, odds of long-term dare service use, and drug/alcohol treatment costs. Overall, the study found no significant change in ED visits, outpatient visits, or inpatient visits for patients in the intervention group. (Bell et al., 2015)

The low program participation in both Bell et al. and Seaberg et al.'s RCT studies suggest that this vulnerable patient population poses follow-up challenges and that matching and DID may be a more feasible analysis techniques for this patient population. Additionally, while many view RCTs as a gold standard of research methodology, they are not without limitations. RCTs require minimal assumptions and can work with little prior knowledge, which can be a disadvantage for building upon prior knowledge to create scientific progress. Randomization does not create balanced treatment and control groups, and the groups it creates are often without thoughtful consideration of observable and unobservable covariates. Finally, RCTs may yield an unbiased estimate, but the estimate is only applicable for the sample selected for the trial, without applicability to other groups. (Deaton and Cartwright, 2017)

Our analysis evaluates the EPIC program, which had a broad scope in eligibility, with all adult ED patients with four or more ED visits in the prior year eligible for the program. Additionally, many have used "one size fits all" interventions that are not individualized, whereas the EPIC program instituted an individualized intervention that catered to the specific needs of each patient. Furthermore, we evaluated the program using a strong analytical combination of propensity score matching and difference-in-differences analysis.

C. Methods

1. Study Setting

EPIC patients were recruited from the University of Illinois (UI) Hospital Emergency Department (ED)- a 24-hour facility in Chicago, Illinois. The hospital is located within the Illinois Medical District and is geographically located within a predominately African-American and Latino neighborhood with a high density of publicly insured residents. UI Hospital's patients mostly reside on the west, south, and southwest sides of Chicago. The hospital's primary service area encompasses 5 of the 10 poorest neighborhoods in the City of Chicago. The annual census of the ED is approximately 28,000 patients and 49,000 visits. Adult patients represent 75% of all ED visits and elderly patients (65 years and older) represent 10% of visits.

The ED's patient population is over half African American and a quarter Hispanic. During the EPIC program period, 39-49% of ED patients were on Medicaid and 9-13% of ED patients were uninsured.

2. **EPIC Program Intervention**

The purpose of the EPIC program was to improve efficient usage of healthcare resources for ED frequent visitors through care coordination. Care coordination is a widespread method for improving care for frequent ED visitors. While care coordination can be inclusive of many elements, overall it is the organization of patient care activities between the patient and one or more participants in order to facilitate the appropriate delivery of healthcare services for the patient. It involves determining the resources needed for appropriate patient care activities and the exchange of information among participants responsible for various aspects of care. From the health care professional perspective, care coordination entails assessing the needs of the patient to identify potential gaps in any needs (e.g., social, medical, behavioral, financial) that may be affecting their use of the healthcare system. The goal is to help the patient navigate effectively and efficiently through the health care system in order to achieve optimal health. (Agency for Healthcare Research and Quality, 2014)

The program was housed in the ED at UI Hospital and enrollment took place from September 2013 to July 2015. Two dedicated full-time program staff- an EPIC social worker and nurse case manager- comprised the EPIC team. The EPIC team was given a list of patients eligible for the program based on the criterion of adults with 4 or more ED visits in the past year. Patients could also be referred to the program by a physician, although this was a very small minority of participants. If an eligible patient presented to the ED, a member of the EPIC team approached the patient, told them about the EPIC program and discussed health care barriers and needs with the patient. Enrollment into the program took place during weekday business hours.

The EPIC team documented the initial and each subsequent interaction with the EPIC patient in an EPIC note in the patient's chart in the electronic medical record (EMR). All patients with an EPIC note in their chart were included in the intervention group. In addition to care coordination interventions from the EPIC team, the EPIC note in the patient's chart has the added benefit of informing ED physicians about the patient's needs. All ED physicians were educated about the EPIC program and EPIC notes. In addition to the availability of the EPIC note in the chart, all patients with EPIC notes had the following message "pop-up" for anyone accessing the patient's chart: "ALERT: This patient has a Care Coordination Note under the ED/EPIC Care Coordination Note folder. Please refer to this note for specific instructions regarding the care management of this patient."

The EPIC team provided program participants with resources based on each patient's individual needs. Table I shows the characteristics of the care coordination interventions. The most common type of intervention needed was primary care support- where participants were given assistance in securing a primary care appointment or were educated on the benefits of using primary care providers. The duration of the program participants' intervention was defined as the date of the first EPIC intervention to the date of the last EPIC intervention. The date of the last EPIC intervention was the patient's last interaction with the EPIC team and did not necessarily coincide with an ED visit, as it could have been over the phone or in person outside of the ED. Participants had an intervention duration of 0 days if their only intervention was an EPIC note.

TABLE I. CHARACTERISTICS OF EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) INTERVENTIONS

N= 452	Mean (Standard Deviation)	Minimum[a]	Maximum
Duration of Program Participation in Days (First EPIC interaction to last EPIC interaction)	107.9 (179.2)	0	767
Most Common Intervention Types Needed	% of participants (of those with interventions)		
Primary Care Support (referral, appointment, or education)	34.0		
Psych Support	26.2		
Transportation	24.6		
Housing	18.8		
Specialist Physician Support	16.5		
Insurance (acquiring or educating on how to change)	16.2		
Prescription Support	14.9		
Substance Abuse Support	9.1		
Intensity Groups	% of participants		
EPIC Note Only	27.2		
Low (EPIC Note + 1 Intervention)	23.5		
Medium (EPIC Note + 2-3 Interventions)	22.1		
Medium-High (EPIC Note + 4-9 Interventions)	15.3		
High (EPIC Note + 10 or More Interventions)	12.0		

[a]Participants with only an EPIC note had an intervention duration of 0 days.

The EPIC program was initiated as a patient-focused quality improvement program, where the care of the patient was at the forefront of the mission, rather than research. As a result, grouping of patient intensity of care and other evaluation-related data categorization occurred after the program ended. Because the case management intervention was individualized, intensity of care was based on number of interventions that the patient received by the care coordination team, based on the descriptions in the EPIC notes. At the conclusion of the program, we counted the number of interventions per person, as described in the EPIC notes. For purposes of evaluation, each intervention was counted and weighted equally. In order to account for the subjective nature of grouping patients by intensity at the time of analysis and in order to ensure accuracy, two study team members independently coded the number of interventions and compared their coding to determine any discrepancies. The four-person analysis team then met to discuss any discrepancies and determine group consensus on the number of interventions for these patients.

As shown in Table I, we categorized the intensity of the intervention into five groups- 1) EPIC note with no intervention, 2) Low intervention, 3) Medium intervention, 4) Medium-High intervention, and 5) High intervention. For the first group, these patients had an EPIC note in their chart, but did not need any other intervention that was identified and completed by the EPIC team. Low intervention was defined as 1 intervention acted upon by EPIC staff, medium was 2 or 3 interventions, medium-high was 4 to 9 interventions, and high was 10 or more interventions.

3. Sample

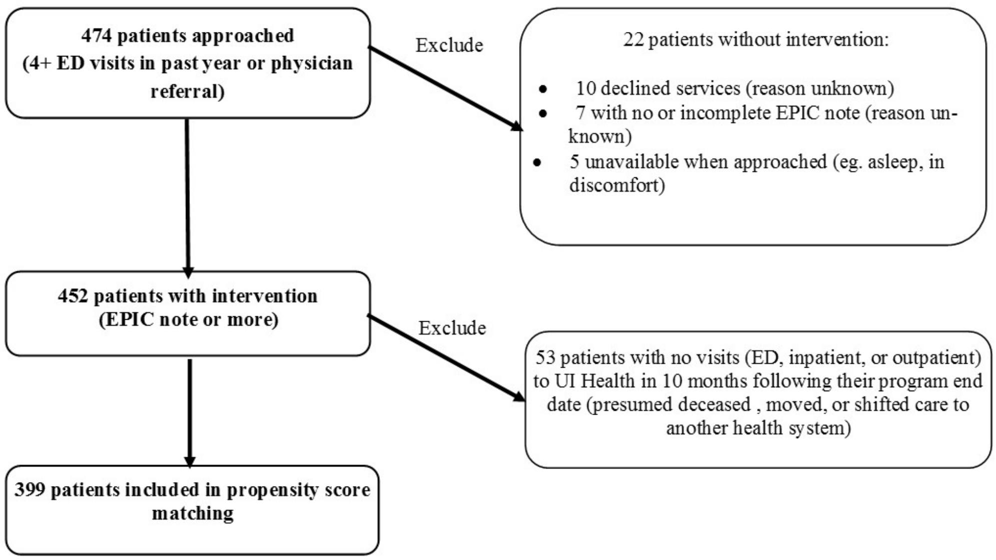
In the case of the EPIC program, determination of who received the intervention was based on which eligible patients (4 or more ED visits) were in the ED when a member of the EPIC team was recruiting potential participants. EPIC team members approached as many of these patients that they could, given their time constraints. There was no determination by the EPIC team of who should or should not be approached and 95% of patients approached about the program participated. There are a few reasons why eligible patients may not have been approached by the EPIC team- 1) Study staff were busy providing interventions on days that comparison patients came to the ED, therefore the comparison group may be over-sampled and the intervention group under-sampled during busy times; 2) Comparison patients came to the ED during non-business hours, when EPIC program staff were not recruiting, so the comparison patients may be more likely to be employed. (A sub-analysis of this sample, grouping patients based on the time of arrival to the ED, can be found in Tables XXXII-XXXV, Appendix A.)

Figure 1 shows the first phase of determining eligible intervention patients for analysis. Of the 474 patients approached for the program, 22 (4.6%) did not participate in the program-either they were unavailable, declined participation (for reasons unknown), or had an incomplete EPIC note (for reasons unknown). These patients were excluded from analysis and were also not included in the comparison group pool. Of patients with an intervention, 53 participants were excluded because they had no visits (ED, inpatient, or outpatient) to the UI Hospital System within 10 months after their last program intervention, which was our check to presume that the patient died, moved, or shifted care to another health system. We assumed that this was a random exit, and not caused by the EPIC program.

In order to get a group of patients which was similar to the intervention group but was never approached for program participation, we created a group of possible comparison patients. This comparison pool was comprised of patients who had 4 or more ED visits in the past year and had at least one ED visit in the month of their eligibility.

Since enrollment for the EPIC program was rolling, we determined an appropriate comparison group for the intervention patients each month to account for possible temporal changes in ED usage. For example, for the intervention group that enrolled in the program in September 2013, the comparison group pool was comprised of patients with 4 or more ED visits from September 2012 to August 2013 who were not approached about EPIC. For the intervention group that enrolled in EPIC in October 2013, the comparison group pool was comprised of patients with 4 or more ED visits from October 2012 to September 2013 who were not approached by the EPIC team. The comparison group had 4502 patient visits, composed of 1556 unique patients. The mean number of months that a patient was included in the comparison group for as a potential comparison patient was 2.9 (SD= 2.7), with a minimum of 1 and a maximum of 17 months. More information on the number of patients enrolled in the intervention and eligible for the comparison pool by month can be found in Figure 18, Appendix A.

Figure 1. Emergency Patient Interdisciplinary Care (EPIC) Analysis Exclusion Flow Chart- Phase 1: Eligible Intervention Patients for Propensity Score Matching



4. <u>Data Source</u>

All data were from UI Hospital's Cerner (Cerner Corporation, Kansas City, MO) electronic medical records. We looked at EPIC notes in the EMR to determine details of each participant's intervention, such as program start and end dates. We also used the EMR data to get demographic variables of interest and visit counts by month. All data cleaning and analysis was completed using Stata Version SE 14.2 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

D. <u>Research Design</u>

This study was a quasi-experimental design utilizing propensity score matching in combination with difference-in-differences (DID) analyses. We compared pre-post changes in patients who participated in the EPIC intervention with a group of ED patients who were eligible to participate in the program but were never approached by the EPIC team. The combination of propensity score matching and DID is beneficial because it can overcome some limitations that occur when each method is used alone. While matching methods reduce bias substantially, they do not eliminate them completely. (Heckman, 1997) Use of propensity score matching cannot account for unobserved characteristics that could potentially explain why individuals enroll in a program and that might also affect the outcomes examined. (Gertler et al., 2011; O'Neill et al., 2016) Using difference-in-differences estimation in addition to matching is generally more effective in removing bias from the data- especially when bias may have temporally-invariant elements such as unobserved site effects. (Heckman, 1997)

1. <u>Propensity Score Matching</u>

a. <u>Determining Which Covariates to Include</u>

First, we determined which covariates were available in our data or could be measured using other elements of our data among all potentially relevant and important covariates that prior literature suggests may contribute to a patient's use of the ED, inpatient care, or outpatient care- as these were our study's outcomes. We used the following covariates: age, gender, race, ethnicity, insurance type, homelessness, sickle cell disease, poverty level of patient's census tract, ED visits 6 months before start of program, inpatient visits (admissions) 6 months before start of program, outpatient visits 6 months before start of program, and poverty level of patient's census tract (low, medium, and high tertiles). Specific explanations for inclusion of each variable are found below.

1) Age

Emergency department utilization has been found to vary by age. According to the 2015 National Hospital Ambulatory Medical Care Survey (NHAMCS), 25-44 year olds made up the highest percentage of ED visits (28.6%), followed by 45-64 year olds (21.3%), people under 15 years (19.8%), people 65 years and older (15.6%), and then 15-24 year olds (14.7 %). People 25-44 years old also had the highest number of visits per 100 persons per year with 47.3 visits, followed by 15-24 years (47.0), 65+ years (46.0), under 15 years (44.5), and 45-64 years (35.0). (Rui and Kang, 2017) According to the 2015 National Ambulatory Medical Care Survey (NAMCS), people 65 years and older had the highest proportion of office visits compared to the other age groups at 30.9%. Their visit rate (number of visits per 100 persons per year) of 657.8 was more than twice the average for all age groups (313.3). For 45 to 64 year olds, the rate was also above the average, at 366.3 visits, and represents 30.8% of all office visits. All other age groups had a lower than the average rate. (Rui and Okeyode, 2017)

2) Gender

One study found that, compared to males, females are significantly more likely to have 5+ ED visits annually for non-emergent needs. (Behr and Diaz, 2016) The 2015 NHAMCS found that the number of ED visits per 100 persons per year was 46.9 for women, compared to 39.5 for men. (Rui and Kang, 2017) Females also had more physician office visits than men, with 59.1% of visits, and 362.2 visits per 100 persons per year compared to 262.1 for men.(Rui and Okeyode, 2017) The higher overall utilization of healthcare (ED and physician office) by females suggests that this is a relevant variable to match patients in the intervention and control groups.

3) <u>Race</u>

Black patients are significantly more likely to have 3+ ED visits for non-emergent needs compared to other races.(Behr and Diaz, 2016) According to the 2015 NHAMCS, white patients made up a higher percentage of ED visits (73.3%) than black patients (23.3%) or other (3.4%). However the number of visits per 100 persons per year was higher for black patients (77.3) than white patients (41.1). (Rui and Kang, 2017)

4) <u>Ethnicity</u>

Differences in ED and outpatient visits differ by ethnicity, where Hispanic patients have lower rates of ED and outpatient visits than non-Hispanic patients. According to the 2015 NHAMCS, Hispanic patients made up 16.5% of all ED visits in the US, with a rate of 40.4 visits per 100 persons per year, compared to non-Hispanic patients with 83.5% of visits and 43.9 visits per 100 persons per year.(Rui and Kang, 2017) According to the 2015 NAMCS, Hispanic patients made up 14.1% of all physician office visits, with a rate of 250.0 visits per 100 persons per year, compared to non-Hispanic patients with 85.9% of visits and 326.9 visits per 100 persons per year. (Rui and Okeyode, 2017)

5) <u>Insurance Type</u>

Nationally, the 2015 NHAMCS estimated that the payer composition for ED patients was 34.3% private insurance, 34.8% Medicaid or CHIP, 17.7% Medicare, 3.6% Medicare and Medicaid, and 9.8% no insurance. (Rui and Kang, 2017) Over half of physician office visits in 2015 were by patients with private insurance (55.8%), followed by Medicare patients (27.2%), Medicaid patients (15.8%), patients with no insurance (5.2%), and patients with Medicaid and

Medicare (2.0%). (Rui and Okeyode, 2017) One study found that patients with Medicare or Medicaid were 2.6 times more likely to have 5+ ED visits in a year for non-emergent needs compared to other insurance types. (Behr and Diaz, 2016) Frequent ED users are more likely to have Medicaid insurance (Sandoval et al., 2010; Vinton et al., 2014) and are less likely to be uninsured or have private insurance. (Sandoval et al., 2010)

6) <u>Homelessness</u>

Homelessness was included as matching variables due to the unique health concerns that accompany the condition. Homeless patients have very high rates of ED utilization. Nationally, the average number of visits per 100 persons per year was 43.3 in 2015. For homeless patients, the number of visits per 100 persons per year was over 3 times higher at 154.0. The only group with more visits is people in nursing homes. (Rui and Kang, 2017) One descriptive study of a care plan program intervention in ED patients with serious psychiatric disorder found a decrease in number of ED visits for all participants except those who were homeless (Abello et al., 2012), suggesting that the homeless may have different needs than non-homeless patients.

7) <u>Sickle Cell Disease</u>

Sickle cell disease (SCD) causes frequent pain crises requiring ED visits and hospital admissions. UI Hospital houses the Sickle Cell Center (SCC), which is the only comprehensive center in Chicago that treats both adults and children with SCD providing inpatient and outpatient care. Due to the resources available at UI Health for SCD patients, many people with SCD choose UI Health as their site to receive care. Due to the nature of SCD, healthcare utilization is unique compared to other diseases. People with sickle cell disease have significantly higher rates of ED visits than people without sickle cell disease. (Shankar et al., 2005) Additionally, outside of UI Hospital, studies have shown that SCD pain crisis has among the highest admission rates from the emergency department for any diagnosis, with rates ranging from 64.8 to 85.7 admissions per 100 patients (64.8% and 85.7%, respectively). (Woods et al., 1997; Lanzkron et al., 2010)

8) <u>Poverty Level for Patient's Census Tract</u>

Poverty plays a central role to vulnerability and the level of risk for poor physical, psychological, and/or social health. (Aday, 1994) Additionally, patients in areas of high poverty may have different health care options and alternative to the emergency department compared to patients in areas of low poverty. A qualitative study (Kangovi et al., 2013) of 40 urban low-socioeconomic status (SES) patients found that they preferred hospital care over ambulatory care, as they perceived it to be less expensive, higher quality, and more accessible. (Kangovi et al., 2013)

Level of poverty was not an available variable in the electronic medical record. As a result, we mapped the home address of each patient using ArcGIS to determine each patient's census tract and then found the percent below the poverty level in the past 12 months for the patient's census tract. The poverty data came from the U.S. Census Bureau 2009-2013 5-Year American Community Survey. Poverty level was grouped into tertiles of low, medium, and high.

9) <u>Number of ED Visits Prior to Program</u>

We looked at number of ED visits 6 months prior to the start of the program, in order to compare intervention and comparison patients who were using the ED at similar magnitude before the program began. The continuous number of ED visits prior to the program was converted into categorical variables of the tertiles of ED visits. Low visits were patients with 0-4 ED visits in the 6 months before the program, medium visits were those with 5 to 7 visits 6 months before the program, and high visits were those with 8 or more ED visits 6 months before the program. Patients in the high ED visit groups were the “superutilizers”, or those who are the highest utilizers of the ED.

10) <u>Number of Inpatient Visits (Admissions) Prior to Program</u>

Number of inpatient visit can act as a proxy for the disease severity of the patient. Frequent ED users have a substantial burden of disease. (Billings and Raven, 2013) Frequent ED users are more likely to report worse general health status compared to non-frequent ED users (Hunt et al., 2006; Sandoval et al., 2010; Zuckerman and Shen, 2004; Vinton et al., 2014) and are more likely to have a chronic disease (Vinton et al., 2014). It is estimated that 84% of high ED users have chronic conditions, and 31% of their ED visits are related to their chronic condition. (Peppe et al., 2007) Frequent ED users tend to be sicker than non-frequent ED users and were hospitalized at higher rates. (Fuda and Immekus, 2006; Sun et al., 2003) A study in New York City showed that the number of chronic conditions and proportion of patients who have a chronic condition increases as the number of annual ED visits increases. (Billings and Raven, 2013)

11) <u>Number of Outpatient Visits Prior to Program</u>

Frequent ED users are much more likely than non-frequent users to have a primary care physician (PCP) (Sandoval et al., 2010; Sun et al., 2003) and more outpatient visits (Hunt et al., 2006; Peppe et al., 2007; Zuckerman and Shen, 2004; Vinton et al., 2014). Because frequent visitors are known to overall be sicker than non-frequent visitors, it is important to match patients on their existing use of health care venues- such as outpatient clinics- before the start of the program.

b. Balance Testing of Covariates in Intervention versus Comparison Group

We determined if significant differences existed in the intervention and comparison groups by performing Z-tests of proportions (for binary variables) and t-tests (for continuous variables) and calculating the standardized differences of means between the groups (see Table II). The standardized difference is beneficial because, unlike hypothesis testing (t-tests and Z-tests), it does not take into account sample size. While there is no clear consensus, generally researchers have proposed that the absolute standardized difference should be less than 0.10 for there to not be a significant difference between the groups (Austin, 2009; Normand et al., 2001), although less than 0.20 may be appropriate if the sample size is modest. (Austin, 2009)

Table II showed that the intervention group had significantly more African Americans, less patients with "other" race, and less Hispanics than the comparison group. In the intervention group, there were also less pre-program ED visits, more inpatient visits, as well as more homeless patients and patients with sickle cell disease, compared to the comparison group. There were several covariates that significantly differed between the groups, suggesting the need for matching to make the two groups more similar in observable patient characteristics.

c. Propensity Score Matching Background

In an observational study such as ours, treated subjects often differ from comparison subjects, so a direct comparison of outcomes between the two groups provides a biased estimate. (Austin, 2011) Balancing scores, such as the propensity score, are meant to deal with the "curse of dimensionality" where a high dimensional vector X limits conditioning on all relevant covariates. (Caliendo and Kopeinig, 2008; Rosenbaum and Rubin, 1983) The propensity score is "the conditional probability of assignment to a particular treatment given a vector of observed covariates". (Rosenbaum and Rubin, 1983) In observational studies without randomization, it is

TABLE II. COMPARISON OF MATCHING VARIABLES FOR EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM PARTICIPANTS AND COMPARISON PATIENTS PRIOR TO PROPENSITY SCORE MATCHING- POOLED ACROSS ALL MONTHS

Patient Characteristics	All Intervention Patients Included in Analysis, N=399	All Comparison Patients Visits[c], N= 4502	p-value[b]	Standard-ized Difference
Race				
% African American	79.1	68.6	**0.000**	0.241
% White	7.0	7.7	0.657	-0.024
% Other	13.8	23.7	**0.000**	-0.256
Ethnicity				
% Hispanic	12.5	20.4	**0.000**	-0.216
Age, Mean (SD)	46.4 (16.2)	46.3 (16.9)	0.923	0.005
Gender				
% Female	61.4	62.9	0.546	-0.031
Insurance Type				
% Medicaid	47.4	42.6	0.068	0.095
% Private	9.0	11.6	0.119	-0.085
% Uninsured	11.5	13.7	0.228	-0.065
% Medicare	28.1	29.7	0.506	-0.035
% Other	1.0	2.3	0.084	-0.104
Tertiles of ED Visits 6 Months Pre-Program				
% Low (0-4 visits)	67.4	34.8	**0.000**	0.690
% Medium (5-7 visits)	18.3	43.5	**0.000**	-0.567
% High (8+ visits)	14.3	21.7	**0.001**	-0.193
Inpatient Visits 6 Months Pre-Program, Mean (SD)	1.8 (2.3)	1.3 (1.7)	**0.000**	0.235
Outpatient Visits 6 Months Pre-Program, Mean (SD)	5.6 (6.6)	5.5 (6.6)	0.678	0.022
% Homeless	11.8	7.6	**0.003**	0.143
% Sickle Cell Disease	18.8	13.1	**0.001**	0.157
Tertiles of Poverty Level for Patient's Census Tract				
% Low	30.4	32.4	0.425	-0.043
% Medium	34.8	33.7	0.656	0.024
% High	34.8	33.9	0.732	0.018

[a]For comparison patients eligible for comparison group in multiple months, demographic information is that from all months of eligibility (patients may be counted more than once).
[b]Using Z-test of proportions for all except t-test for Inpatient Visits 6 Months Pre-Program, Outpatient Visits 6 Months Pre-Program, and Age (continuous)

important to compare treatment and control groups that are balanced for a set of observed covariates. (Rosenbaum and Rubin, 1983)

There are two major assumptions in propensity score matching. The first, known as “unconfoundedness” (Rosenbaum and Rubin, 1983), “selection on observables” (Heckman and Robb, 1985), or the “conditional independence assumption (CIA)” (Lechner, 1999) says that systematic differences in outcomes for the treatment and comparison groups with equal values for the covariates can be attributed to the treatment. (Caliendo and Kopeinig, 2008) There is no way to test the CIA assumption.

In our data, the intervention group patients who presented to the ED during business hours (i.e., when EPIC enrollment took place) and the comparison group patients who presented during non-business hours may have different characteristics. For example, those who present during business hours may be unemployed and/or may not have a primary care provider. To account for these potential differences, it is important to match patients in the intervention group to patients in the comparison group on all possible characteristics that could affect their utilization of health care services. However, we are limited because we are only able to match on the observable variables that we have available in the data. While we have observable variables available to use for matching, the matching still may be less than perfect given unobserved heterogeneity between the two groups. .

The common support assumption says that people with the same value of covariates have a positive probability of being in both the treatment and comparison groups. (Heckman et al., 1999) One issue of matching is the “common support problem”, where there may be no similar observations in the comparison group for some treated group observations. In our analysis, we only included patients who were within the region of common support. Implementing the common support condition in propensity score estimation may increase the match quality used to estimate the average treatment effect on the treated (ATT). (Becker and Ichino, 2002)

While it is possible to use regression equations to control for covariates that differ between the treatment and comparison groups, there are several reasons why matching is more efficient.(Austin, 2011; Rosenbaum and Rubin, 1983) First, assuming a balanced propensity score, the distribution of observable baseline covariates is similar between both the treatment and comparison groups. The diagnostics for determining if these two groups have similar distributions is much more difficult in a regression model. (Austin, 2011) Additionally, propensity score matching allows for examination of the degree of overlap in the distribution of baseline covariates between the groups, which is difficult to determine using regression equations. (Austin, 2011)

d. Propensity Score Matching Methods for this Analysis

In terms of which variables to include in the propensity score model, the number and reasoning of variable inclusion has been the subject of debate. Omitting important variables can increase bias in resulting estimates (Heckman, 1997). Variables should be either fixed over time or measured before program participation. (Caliendo and Kopeinig, 2008) It is important to take into account theory, previous research findings, and institutional knowledge to determine which variables should be included in the model. (Caliendo and Kopeinig, 2008) Bryson et al. (2002) recommend that over-parameterized propensity score models should be avoided for two reasons. First, including extraneous variables may exacerbate the common support problem. Second, including non-significant variables will not bias estimates, but can increase their variance. (Bryson et al., 2002) However, Rubin and Thomas (1996) argue that a variable should only be excluded if the variable is unrelated to the outcome or not an actual covariate. If there is any uncertainty of whether these criteria pertain to a variable, the variable should be included in the estimation. (Rubin and Thomas, 1996) Austin (2011) suggests that despite the lack of agreement on which variables to include, the possible variable sets are: "all measured baseline covariates, all baseline covariates that are associated with treatment assignment, all covariates that affect the outcome (i.e., the potential confounders), and all covariates that affect both treatment assignment and the outcome (i.e., the true confounders)". (Austin, 2011) For this analysis, we have chosen to include all observable covariates that are believed to be related to the outcome, for the main analysis. Additionally, we have provided a sensitivity analysis of the findings using any of these covariates believed to be related to the outcome, which also affect treatment assignment. The covariates that affected treatment assignment were determined based on a comparison of EPIC participants who arrived to the ED during weekday business hours (9am-5pm) when EPIC was recruiting, and eligible EPIC patients who were never approached for the program who arrived to the ED during weekday business hours. This analysis can be found in Tables XXXVI-XXXIX, Appendix A.

There are several methods for matching based on the propensity score including nearest-neighbor matching, radius matching, kernel matching, and stratification matching. Each method has strengths and weaknesses. For this analysis we used 1:1 nearest neighbor matching. This method matches each treated unit to the comparison unit with the closest propensity score. The nearest neighbor approach allows for a match for all treated units, but because all units are matched, some matches are poor, as treated and comparison closest matches might have very different propensity scores. (Becker and Ichino, 2002) When using nearest neighbor matching, it is also possible to match multiple comparison units to each treated unit, however doing so increases bias. For example, the second and third closest matches are further from the treated unit than the closest match. At the same time, the larger matched sample size of multiple matches can decrease variance. (Stuart et al., 2014)

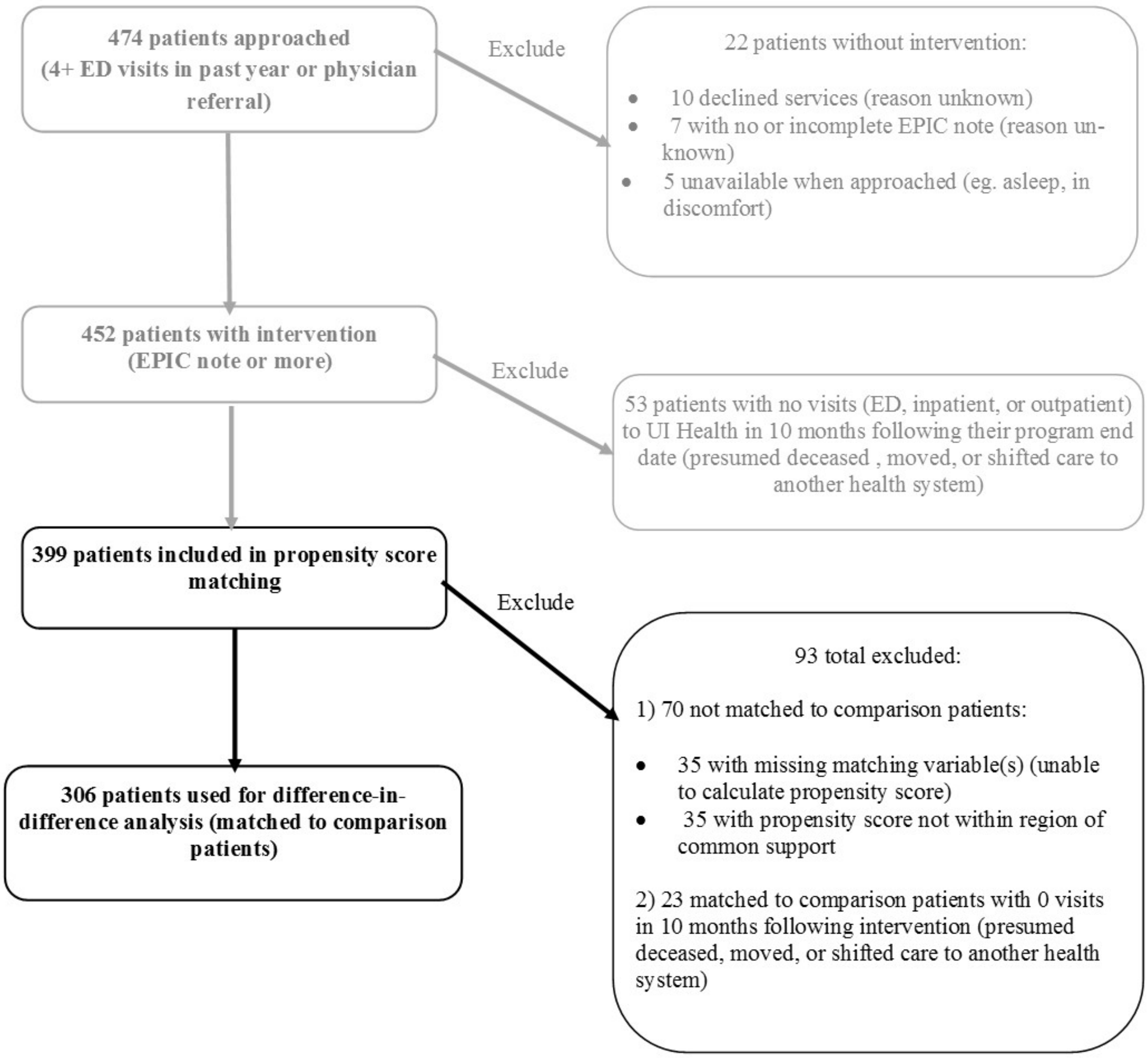
The nearest neighbor method can be completed with replacement or without replacement, where replacement is when a comparison unit can be a best match for multiple treated units. (Becker and Ichino, 2002) Matching with replacement can decrease bias because comparison units that are similar to multiple treated units can be used repeatedly. However, matching with replacement increases variance because of non-independence of observations. It is possible when matching with replacement that the treatment effect estimate will only be based on a small number of comparison units, rather than all unique observations. (Stuart et al., 2014) For this analysis, we used matching without replacement. We also repeated the analysis using matching with replacement, results of which can be found in Tables XL-XLII, Appendix A.

Probit was used to estimate the propensity scores. February and March 2015 treatment patients, as well as the comparison patients of the two months, were combined to obtain propensity scores and matches because the small sample size (n=5) of patients in the February 2015 intervention group led to challenges for the probit model to predict assignment to treatment group. June 2015 and May 2015 were also combined because of the small number of patients (n=3) enrolled in June 2015.

e. Sample for Difference-in-Differences Analysis

As shown in Figure 2, of the patients in the intervention group, 35 were not matched because of missing values (12 missing poverty because they were missing a valid home address in the EMR, 1 missing race, and 20 missing ethnicity, with 2 missing poverty and ethnicity), and 35 were not matched because their propensity scores were not within the area of common support with the comparison group. For those individuals who did not receive propensity scores

Figure 2. Emergency Patient Interdisciplinary Care (EPIC) Analysis Exclusion Flow Chart- Phase 2: Eligible Intervention Patients for Difference-in-Differences Analysis



because of missing values, we tested that these patients do not have significantly different observed characteristics than those without missing values. The only significant difference was that there was a greater proportion of uninsured patients for individuals with missing data than those without missing data. (p=0.035). This analysis can be found in Table XLIII, Appendix A.

Matched comparison patients were assigned pseudo-enrollment start and end months that mimicked the dates of their matched intervention patient. In order to make sure that people in the comparison group did not move out of the area or die during the time period of interest all potential patients in the comparison group were required to have at least one visit at UI Hospital (ED, inpatient, or outpatient) in the 10 months following their last program intervention. After the first round of matching, there were 38 individuals in the comparison group who had no visits in the 10 months after the end of the program for their intervention match. As a result, we repeated the matching algorithm after dropping these 38 comparison group individuals. Doing so resulted in 23 comparison group individuals who had no visits for 10 months after their match's program end month. We then dropped these 23 matched pairs (intervention and comparison individuals) from analysis so that the results of our difference-in-differences analysis would not be skewed by the inclusion of comparison group individuals who may have died, moved, or changed health care providers during the analysis period.

Table III compares the final sample of intervention and comparison patients after propensity score matching. Matching allowed for similar groups such that no matching variables were statistically different between the comparison and intervention groups.

2. <u>Difference-in-Differences Analysis</u>

If our analysis was limited to a comparison of pre-intervention and post-intervention outcomes for patients who participated in the EPIC program, it is likely that such an analysis

TABLE III. EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM PARTICIPANTS AND COMPARISON PATIENTS AFTER PROPENSITY SCORE MATCHING USING NEAREST NEIGHBOR 1:1 MATCHING WITH NO REPLACEMENT

Patient Characteristics	Patients with Intervention, N= 306	Comparison Patients, N= 306	p-value[a]	Standardized Difference
Race				
% African American	78.8	82.0	0.309	-0.082
% White	6.5	4.9	0.384	0.070
% Other	14.7	13.1	0.559	0.047
Ethnicity				
% Hispanic	13.7	11.4	0.394	0.069
Age, Mean (SD)	47.3 (16.0)	46.9 (16.8)	0.736	0.027
Gender				
% Female	63.1	63.4	0.933	-0.007
Insurance Type				
% Medicaid	49.3	47.7	0.686	0.033
% Private	10.1	13.1	0.256	-0.092
% Uninsured	10.8	9.8	0.690	0.032
% Medicare	28.4	28.1	0.929	0.007
% Other	0.3	1.3	0.178	-0.109
ED Visits 6 Months Pre-Program				
% Low (0-4 visits)	66.0	65.4	0.865	0.014
% Medium (5-7 visits)	20.3	20.9	0.842	-0.016
% High (8+ visits)	13.7	13.7	1.000	0.000
Inpatient Visits 6 Months Pre-Program, Mean (SD)	1.7 (2.1)	1.7 (1.9)	0.937	0.006
Outpatient Visits 6 Months Pre-Program, Mean (SD)	5.6 (6.1)	5.6 (6.2)	0.963	0.004
% Homeless	8.8	7.5	0.555	0.045
% Sickle Cell Disease	16.3	16.0	0.913	0.009
Poverty Rate in Patient’s Census Tract				
% Low	29.7	29.1	0.859	0.014
% Medium	35.0	33.7	0.733	0.027
% High	35.3	37.3	0.614	-0.041

[a]Using Z-test of proportions for all except t-test for Inpatient visits, Outpatient visits, and Age (continuous)

would be affected by temporal trends in the outcomes of by the effects of events that occurred between the pre and post time periods, other than the treatment. In difference-in-differences (DID) analysis, "an untreated comparison group can be used to identify temporal variation in the outcome that is not due to treatment exposure". (Abadie, 2005) A strong assumption of DID is that "in the absence of the treatment, the average outcome for the treated and control groups would have followed parallel paths over time". (Abadie, 2005) This assumption may not hold true if "pre-treatment characteristics that are thought to be associated with the dynamics of the outcome variable are unbalanced between the treated and the untreated". (Abadie, 2005) As such, since we know that our intervention and comparison groups are balanced (Table III), we believe that this assumption holds true in our analysis. In addition to creating a matched pair sample on observable demographic characteristics, we matched on number of ED, inpatient, and outpatient visits (our outcomes) in the pre-program period in order to obtain comparison group patients who were similar in these outcomes before the start of the program.

After the propensity score matching described above, difference-in-differences analysis was conducted to compare pre and post changes in the outcomes between the two groups, using the following models:

$$(1) \quad Y_{gt}^{j} = \beta_0 + \beta_1 Treat_g + \beta_2 Post1_t + \beta_3 Treat_g x Post1_t + \beta_4' X_{gt} + \varepsilon_{gt}$$

$$(2) \quad Y_{gt}^{j} = \gamma_0 + \gamma_1 Treat_g + \gamma_2 Post2_t + \gamma_3 Treat_g x Post2_t + \gamma_4' X_{gt} + \mu_{gt}$$

Y_{gt} were outcome variables, where *j* was each of the three outcomes- number of ED visits, outpatient visits, and inpatient visits during the time frame of interest (6 months post-program and 10 months post-program). $Treat_g$ was the group assignment where 1 was the intervention

(EPIC) group and 0 was the comparison group. In Equation (1), $Post1_t$ was a time variable where 0 was six months pre-program and 1 was six months post-program. In Equation (2), $Post2_t$ was a time variable where 0 was ten months pre-program and 1 was ten months post-program. $Treat_g xPost1_t$ and $Treat_g xPost2_t$ were group and time interactions, which were the difference-in-differences (DID) estimate. The DID estimate was the amount of change in the post- versus the pre-period for the intervention versus the comparison groups. X_{gt} represented covariates of race (white, black, other), ethnicity (Hispanic, Non-Hispanic), age, sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), homelessness (yes, no), patient has sickle cell disease (yes, no), poverty in patient's census tract (low, medium, and high tertiles), and study duration (in days). ε_{gt} and μ_{gt} were the error terms. In the model, subscript for each group was notated as *g* and each time period as *t*. Two observations were used for each individual for each model- one in the pre-period and one in the post-period. Covariates for the pre-period observation were those from the enrollment visit (in the case of the EPIC intervention group) or from the first ED visit in the eligibility month (in the case of the comparison group). Covariates used for the post-period were those of the first ED visit during or after the last month of the intervention period. Out of our 612 patients used in the analysis, there were 66 patients that did not have an ED visit during or after the last month of the intervention period, so their post-period covariates came from their closest ED visit to the end of the intervention period.

In addition to looking at all program participants as a whole (those in the intervention group and their matched pairs in the comparison group), we determined if intensity of program intervention (only EPIC note, low, medium, medium-high, and high) resulted in differing levels of change in these outcomes. Our analysis was stratified based on intensity level of intervention- which could not be found in any published literature on interventions for ED frequent visitors.

3. Outcomes

Outcomes of interest were the number of ED visits, outpatient visits, and inpatient visits 6 months post-program and 10 months post-program at UI Hospital ED. All time periods were assessed at the month level. The post-program periods began the month following the last intervention for each participant and ended 6 months and 10 months later. For example, if an intervention patient started EPIC in September 2013 and ended in November 2013, the 6 month post-period would be the number of visits from December 2013 to May 2014. The 10 month post-period would be the number of visits from December 2013 to September 2014. Start and end dates for patients in the comparison group mirrored the start and end dates for their matched pair in the intervention group.

While most published studies have focused their outcomes on changes in ED visits, our evaluation also examined outpatient and inpatient visits. Looking at each type of patient visit (ED, outpatient, and inpatient) allowed us to determine, not only if ED visits had decreased, but if outpatient visits increased as a result of the program. Such a finding would suggest that patients shifted to more efficient care (with primary care providers or specialists), with more continuity of care than the ED. There are several reasons that these outcomes are important to explore. First, frequent visitors are known to be medically complex (Hunt et al., 2006; LaCalle, 2010), so we expect patients to continue to require medical services through primary and secondary care in an outpatient setting. Second, because we only have data from one hospital, we do not know if patients have traveled to additional EDs outside of the study site, so a decrease in ED visits at our site may not signify an overall decrease in ED visits if the patient goes to other sites. However, by looking at outpatient visits as well, we can see if patients have shifted their care from the ED to an outpatient setting within our health care system. Third, while we had no a priori hypothesis for inpatient visits, we looked at inpatient visits in order to get a full picture of health care utilization changes in EPIC patients versus the comparison group after the program.

E. Results

Tables IV and V show the DID models that were run for each time period of interest (6 months post-program and 10 months post-program, respectively). The coefficients of interest were β_3 and γ_3- the DID estimates- representing the change in the post versus pre-period for the intervention group versus the comparison group.

The goal of the EPIC program, that ED visits would decrease for participants, was not found in our results. Instead we found the opposite- that they increased. In Table IV, for the time period of the pre-EPIC period versus 6 months after EPIC, there was a significant increase of 2.5 ED visits for the intervention group compared to the comparison group. Table V shows a significant increase of 2.9 ED visits from the pre-EPIC period to 10 months after EPIC for the intervention group compared to the comparison group. We also expected outpatient visits to increase as a result of program participation, but for both post-program periods, there were no significant changes in inpatient or outpatient visits, comparing the intervention and comparison groups from pre-program to post-program. These findings suggest the possibility that program participants may have felt more satisfied with their care in the UI Hospital ED because of the personalized attention they received from the program. It is also possible that patients may have used multiple EDs prior to the EPIC program, and then shifted their care to only the UI Hospital ED after the EPIC program if they felt a sense of connectedness through program interactions.

In looking at the data by intervention intensity level, Tables IV and V show that the general findings mimicked those of the main analysis for all patients, where number of ED visits was significantly higher for the post-period compared to the pre-period for the intervention group compared to the comparison group. This finding remained true for all intervention intensities and both post-periods except for the highest intensity group, which had no significant difference between the intervention and comparison groups for 6 months or 10 months after the program compared to visits pre-program.

Also, the increase in ED visits was greater as the intervention intensity level increased. For example, the change from pre-EPIC to 6 months post-EPIC for patients with only an EPIC note (the lowest intensity group) had an increase of 2.0 ED visits compared to the comparison group, while the medium-high intervention group had an increase of 3.8 ED visits in the post-period compared to the comparison group.

The magnitude of the increase in ED visits grew as the intensity of the intervention increased. Patients with more interactions with the EPIC team may have felt more connected to the ED than those with less interactions, resulting in preferences for the UI Hospital ED over others. The exception to this finding is the results of the highest intensity group, which saw no significant change in ED visits.

F. <u>Discussion</u>

Overall, there was a significant increase in ED visits from before EPIC started to after EPIC for the intervention group, compared to the comparison group, for both post-period time frames. These findings differed from the intended goal of the program, which was for the EPIC intervention to decrease ED visits and increase outpatient visits. Instead, the intervention increased ED visits and did not affect inpatient or outpatient utilization.

All intervention intensity groups had increased ED visits in the post-period compared to the matched comparison group. The magnitude of the increase in ED visits grew as the intensity of the intervention increased. Patients with more interactions with the EPIC team may have felt

TABLE IV. ADJUSTED DIFFERENCES IN INPATIENT, OUTPATIENT, AND EMERGENCY DEPARTMENT VISITS BETWEEN THE INTERVENTION AND COMPARISON GROUPS BEFORE AND 6 MONTHS AFTER THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM FOR ALL PARTICIPANTS AND BY INTERVENTION INTENSITY GROUP[a, b, c, d]

VARIABLES	All Participants N=612	Only EPIC Note N=180	Low Intensity N=144	Medium Intensity N=138	Medium-High Intensity N=90	High Intensity N=60
INPATIENT VISITS						
Treat	-0.000579	-0.214	-0.365	0.247	0.861**	0.422
	(0.146)	(0.258)	(0.310)	(0.303)	(0.409)	(0.543)
Post1	-0.618***	-0.561**	-0.511	-0.519	-0.651	-0.938
	(0.149)	(0.259)	(0.308)	(0.295)	(0.408)	(0.524)
Treat x Post1 (DID Estimate)	0.279	0.243	-0.0269	0.663	0.0712	0.329
	(0.207)	(0.359)	(0.427)	(0.414)	(0.568)	(0.729)
EMERGENCY DEPARTMENT VISITS						
Treat	-1.250***	-1.853***	-1.440***	-1.467**	-0.427	0.470
	(0.323)	(0.360)	(0.497)	(0.744)	(1.238)	(1.655)
Post1	-3.247***	-2.988***	-3.566***	-3.208***	-3.270***	-3.687**
	(0.328)	(0.361)	(0.494)	(0.725)	(1.236)	(1.598)
Treat x Post1 (DID Estimate)	2.493***	2.027***	2.110***	2.793***	3.800**	2.875
	(0.456)	(0.500)	(0.686)	(1.018)	(1.721)	(2.222)
OUTPATIENT VISITS						
Treat	-0.00875	1.529	0.439	-0.170	-1.057	-1.410
	(0.477)	(0.995)	(0.911)	(0.906)	(1.231)	(1.579)
Post1	-0.542	0.0383	-0.590	-0.564	-0.603	-1.518
	(0.485)	(0.998)	(0.905)	(0.883)	(1.229)	(1.525)
Treat x Post1 (DID Estimate)	-0.0163	-0.862	0.645	-0.531	0.0346	1.274
	(0.674)	(1.382)	(1.256)	(1.241)	(1.712)	(2.121)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), homeless (Y/N), sickle cell disease (Y/N), poverty level of census tract (low, medium, high), and study duration (days).

[c] Using 1:1 nearest neighbor matching without replacement.

[d] N is the total number of EPIC intervention and comparison patients.

TABLE V. ADJUSTED DIFFERENCES IN INPATIENT, OUTPATIENT, AND EMERGENCY DEPARTMENT VISITS BETWEEN THE INTERVENTION AND COMPARISON GROUPS BEFORE AND 10 MONTHS AFTER THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM FOR ALL PARTICIPANTS AND BY INTERVENTION INTENSITY GROUP[a, b, c, d]

VARIABLES	All Participants N=612	Only EPIC Note N=180	Low Intensity N=144	Medium Intensity N=138	Medium-High Intensity N=90	High Intensity N=60
INPATIENT VISITS						
Treat	-0.00602	-0.199	-0.402	0.239	0.856	0.393
	(0.190)	(0.326)	(0.409)	(0.396)	(0.543)	(0.718)
Post2	-0.0316	0.161	0.187	0.0270	-0.332	-0.348
	(0.193)	(0.327)	(0.406)	(0.386)	(0.542)	(0.694)
Treat x Post2 (DID Estimate)	0.367	-0.0782	-0.107	0.962	0.923	0.230
	(0.269)	(0.453)	(0.564)	(0.542)	(0.755)	(0.964)
EMERGENCY DEPARTMENT VISITS						
Treat	-1.273***	-1.828***	-1.428**	-1.612	-0.451	0.421
	(0.400)	(0.445)	(0.618)	(1.108)	(1.382)	(1.759)
Post2	-1.982***	-1.493***	-2.284***	-1.935	-2.135	-2.810
	(0.406)	(0.446)	(0.615)	(1.080)	(1.379)	(1.699)
Treat x Post2 (DID Estimate)	2.942***	1.643***	2.237***	4.088***	4.636**	3.901
	(0.564)	(0.618)	(0.852)	(1.517)	(1.921)	(2.362)
OUTPATIENT VISITS						
Treat	-0.0389	1.451	0.425	-0.0423	-0.935	-1.907
	(0.634)	(1.303)	(1.201)	(1.218)	(1.662)	(2.220)
Post2	2.657***	3.754***	2.221	2.330	2.469	1.923
	(0.643)	(1.308)	(1.194)	(1.187)	(1.658)	(2.143)
Treat x Post2 (DID Estimate)	-0.464	-0.395	-0.125	-0.915	-1.431	0.263
	(0.895)	(1.811)	(1.656)	(1.667)	(2.310)	(2.980)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), homeless (Y/N), sickle cell disease (Y/N), poverty level of census tract (low, medium, high), and study duration (days).

[c] Using 1:1 nearest neighbor matching without replacement.

[d] N is the total number of EPIC intervention and comparison patients.

more connected to the ED than those with less interactions, resulting in preferences for the UI Hospital ED over others.

The exception to this finding is the results of the highest intensity group, which saw no significant change in ED visits. It is important to consider the possible differences between this high-need group and the other groups. Table XLIV, Appendix A compares patient characteristics between the intervention intensity groups. Intervention individuals with the highest intervention intensity tended to have a higher proportion of homelessness, Medicare, and sickle cell disease, with more ED visits before the program began. They also had less private insurance. While the eligible patients overall portrayed many vulnerable characteristics, this group in particular may be especially vulnerable and difficult to affect. In the case of our study's findings, with all other intensity levels showing a significant increase in ED visits for the intervention group after the program, it may be better that this group had no significant finding, rather than increased ED visits.

Research has shown that ED frequent visitors may only be so for a short time. Several studies have shown that only approximately one-third (28%-38%) of ED frequent visitors in one year remain frequent visitors in the following year. (Cook et al., 2004; Fuda and Immekus, 2006; Kanzaria et al., 2017; Mandelberg et al., 2000) Research has also shown that low income patients tend to prefer the care they receive in a hospital setting more than care in an outpatient setting. A qualitative study (Kangovi et al., 2013) of 40 urban low-SES patients found that they preferred hospital care over ambulatory care, as they perceived it to be less expensive, more accessible, and of higher quality than ambulatory care. Therefore, it is possible that overall, the number of visits for both the comparison and treatment groups declined from the natural cycle of ED frequent visitors remaining so for a brief time, but the treatment group declined less because they felt more connected to the ED and were more satisfied with their care there because of their interactions with EPIC program staff. They may have felt that the ED was interested in helping them, which could have made them feel more connected to the ED, and thus wanted to spend more time there. It may be a better strategy for frequent ED visitor programs like this to be housed at an outpatient setting so that patients connect the interest in their well-being and connectedness to the outpatient setting rather than the ED.

Additionally, inpatient visits (admissions) did not significantly increase for the EPIC participants compared to comparison patients after the EPIC program. Since ED frequent visitors are known to be a medically complex group, we would have expected that an increase in ED visits for the program participants compared to comparison patients may have also shown an increase in inpatient visits for this group. However, since inpatient visits did not significantly increase, this suggests that the coordinated care through the EPIC program may have helped these complex patients control medical conditions so that their ED visits resulted in discharges from the ED and not being admitted to the hospital.

In addition to differing from the program goal of decreasing ED utilization, findings from this study differed from prior literature on other programs for frequent ED visitors that have found a reduction or no significant change in ED visits. Several of these studies have found a decrease in ED use after the program, but have lacked a comparison group.(Abello et al., 2012; Crane et al., 2012; Grover et al., 2010; Newton et al., 2011; Okin et al., 2000; Pillow et al., 2013; Pugh et al., 2010; Raven et al., 2011) If our data were analyzed without a comparison group, our results may have shown a decrease in ED visits after the program for participants, showing the program as a “success”. Tables XLV and XLVI, Appendix A show results of regressions of only the intervention group, comparing change in number of visits before and after the EPIC program, without a comparison group. We found that, without inclusion of a comparison group, there would have been significant findings for change in inpatient and outpatient visits, which we did not find in the main analysis. There also would have been a decrease in ED visits for the 6 month post-EPIC period, for which we found increased when comparing the intervention group to the comparison group. While the change in ED visits in the 10 month post-period was in the same direction as our DID model with the comparison group, the magnitude was smaller without the comparison group and there were no significant findings for any individual intervention intensity groups.

Of studies that evaluated programs that had interventions for ED frequent visitors and had comparison groups, two found no significant decrease in ED visits for the intervention group compared to the comparison group. (Bell et al., 2015; Spillane et al., 1997) Bell et al. (2015) also found no significant difference in inpatient or outpatient visits for the intervention group versus the control group comparing pre-program visits to post-program visits, which is similar to our findings. Another study found significant declines in ED visits over a 12-month post-observation period, but not over a longer 24-month period. (Enard and Ganelin, 2013) This finding follows the prior literature that suggests that frequent visitors may only be frequent for a short time.

Other studies that evaluated programs with a comparison group have found significant decreases in ED visits after the program for the intervention group compared to the comparison group, however the eligibility for the programs have been especially high-risk patients. One study of uninsured program participants found that participants had 32% lower risk of visiting the ED compared to the comparison group after the program, with no difference in inpatient admissions between the groups. (Shah et al., 2011) McCormack et al (2013) evaluated a program for 60 chronically homeless, alcohol-dependent frequent ED visitors and found that there was a decrease of 12 ED visits from the pre-program to post-program period for the intervention group compared to the comparison group. (McCormack et al., 2013) The program's small sample size and high-risk patient population may have contributed to such a large decrease in ED visits.

For this study, we only had access to visit data from UI Hospital. Data from only one site is not ideal because we do not know if participants visited other sites for health care, so our knowledge of their total health care utilization is limited. It is possible that patients who frequented the UI Hospital ED also used other EDs, especially because UI Hospital is located in the Illinois Medical District of Chicago, making it blocks away from two other hospitals/health systems. When patients participated in the EPIC program, they may have decreased their overall ED utilization across all hospitals, and increased their use of the ED at UI Hospital because they favored the care they received from the EPIC program. If this were the case, although we saw an increase in UI Hospital ED visits, the program would be beneficial to the overall healthcare system if it decreased overall ED visits across all sites. Unfortunately, we did not have data available to determine if this took place with the EPIC program's participants. A next step in evaluating the EPIC program would be to obtain claims data that covered all visits to all sites to see if this interpretation of the results is accurate. By looking at ED visits across all sites of care, we could see if there was an overall decrease in ED visits as a whole.

There were several limitations to this study. First, patients were only recruited during business hours on weekdays. Data has shown that approximately 59% of ED visits are made after business hours (Monday-Friday, 8am-5pm) (Rui and Kang, 2017), so this may have led to biases within the intervention group that may not be fully representative of the entire frequent

ED visitor patient population. Other frequent ED visitor studies have mentioned recruiting during weekday business hours as well (Enard and Ganelin, 2013; Sadowski et al., 2009), as this seems to be common for new programs that may have limited hours of staffing. It is possible that patients seen during business hours are different than patients seen after hours. We tried to adjust for these potential differences between the intervention and comparison groups by matching on many observable variables, but there was no way to adjust for unobservable variables. For example, we were not able to match on health access variables- such as having a usual source of care, which could affect how patients use health care.

Second, the program took place in one hospital, limiting the generalizability of findings to similar hospitals. We only had visit data (ED, outpatient, and inpatient) on visits that took place within our health system, which, as previously described cannot give us a full picture of each patient's total healthcare utilization. A review of the literature shows that many frequent ED visitor intervention programs have taken place in only one hospital (Crane et al., 2012; Grover et al., 2010; Lee and Davenport, 2006; McCormack et al., 2013; Newton et al., 2011; Okin et al., 2000; Pillow et al., 2013; Pugh et al., 2010; Raven et al., 2011; Shah et al., 2011; Stokes-Buzzelli et al., 2010), as this may be more cost-efficient while determining if the program is effective before expansion to additional sites. However, this limits the opportunity to fully evaluate the outcomes of the program.

Additionally, we excluded patients from the intervention and comparison groups because they did not have any ED, inpatient, or outpatient visits at UI Health during the 10 months after the month of their last program intervention. We did not know if these patients died, moved, or shifted care to another health system. If they did shift care to another health system and we had data across more health care sites, we could see their visits at these other sites. As a result, we would not have needed to exclude them from analysis, which would have given us a larger sample size and more power.

Third, while the intervention of the EPIC program was a well-defined time period, the time involved varied for each participant. The longer the participant was in the intervention, the more likely that he may have received other interventions outside of the program, which could confound our results. For example, care coordination through Medicaid Managed Care began during the time of EPIC. By January 2015, at least half of the 3 million Medicaid recipients in Illinois were required to move to managed care. (Frost and Frellick, 2014) A health plan could participate in a managed care program in Illinois if they provide a greater range of services, including care coordination, in exchange for a limit on which doctors and hospitals patients can visit. (Frost and Frellick, 2014) This meant that patients with Medicaid Managed Care had the opportunity to receive care coordination through their care plan. In addition to this program being only available to Medicaid Managed Care patients, it was only available for those who were aware of the program. Through the program, care coordinators "checked in" with patients monthly. While the EPIC team could communicate with a patient whenever he showed up to the ED- proving beneficial for hard-to-reach patients such as the homeless or those with unreliable telephone access- the predominant contact method for the Medicaid Managed Care coordinators was the telephone. Although there were differences between the two programs, we cannot ignore the possibility that the program may have interfered with the results of our evaluation. However, because we had balance between insurance type between the intervention and comparison groups, we expect that this program would have affected the two groups equivalently.

Finally, we were unable to observe the long-term outcomes of the EPIC program, which may be welfare improving for participants. Future work that follows the program participants over a longer post-program period would be warranted to explore long-term health effects of the EPIC program.

The indication that program participants increased ED utilization after the program, compared to comparison patients was a new finding in this field. Future studies with strong analytical methods are warranted to determine if there is replication of this finding in other studies. This study exhibits the importance of including a comparison group and having access to data that covers a larger geographical area than only one hospital in order to truly see the effect of the program on its participants. It was possible that program participants may have felt more comfortable or satisfied with their care in the ED because of the program, and future programs that target frequent ED visitors but are physically located in an outpatient setting may be more likely to see a shift in utilization from the ED to the outpatient setting. Patients who frequented multiple EDs before the program may have consolidated their care to only the UI Hospital ED after participation in the program. As a result, obtaining data that provides visits for all patients across all sites of care would be a necessary next step to determining if our interpretation of these findings is accurate.

II. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER AND MEDICAID & UNINSURED PATIENTS' UTILIZATION OF THE EMERGENCY DEPARTMENT OF A HOSPITAL IN CHICAGO, ILLINOIS FOR NON-URGENT HEALTH CARE NEEDS

A. Introduction

Non-urgent emergency department (ED) care is generally defined as a visit for a health condition for which the likelihood of an adverse outcome would not be increased from a delay of care for several hours. (Niska et al., 2010; Uscher-Pines et al., 2013; Young et al., 1996) Non-urgent ED use may lead to exorbitant healthcare spending, treatments that are not necessary, and diminished relationships between the patient and primary care provider. (Uscher-Pines et al., 2013)

Although definitions of non-urgent emergency department (ED) visits vary across studies, a systematic review of the data found that 8-62% of all ED visits were for non-urgent needs. (Uscher-Pines et al., 2013) Some examples of non-urgent definitions have included determination prospectively at triage, review of medical record retrospectively, and retrospective patient self-report. The methods have included varying criteria for the definition of non-urgent including components such as vital signs, ability to wait for care, and timing of visit. (Uscher-Pines et al., 2013)

The 2011 National Health Interview Survey found that of adult ED patients whose visit did not result in a hospitalization, 79% sought care at the ED due to one or more access issue ("didn't have another place to go**,** doctor's office or clinic not open, ED is the closest provider, or ED is usual place to get care"). (Capp et al., 2014)

Patients who have non-urgent needs can be seen in a primary care setting, rather than the ED. For low-income and uninsured patients, federally qualified community health centers

(FQHCs), also called community health centers, are a viable option for primary care, as they accept all patients regardless of insurance or ability to pay. They are in high-need areas and tailor their services to fit the priorities of the community. (National Association of Community Health Centers, 2016) FQHCs are significantly more likely to grant new patient appointments for Medicaid patients compared to non-FQHC providers, and offer uninsured patients more affordable services than non-FQHC providers. (Saloner et al., 2014)

After the economic recession of 2008, the American Recovery and Reinvestment Act (ARRA) was signed into law in February 2009. ARRA allocated two billion dollars for FQHCs, including $155 million in funding for 126 new access points (NAP) for health centers. (Shin et al., 2010) From February 2009 to July 2011, the number of full-time FQHCs in the 9 miles surrounding University of Illinois (UI) Hospital increased from 95 to 124.

The purpose of this analysis was to explore the impact of being closer to a FQHC on non-urgent ED utilization of UI Hospital ED patients and within patient changes in distance that occurred during the bulk of FQHC openings from ARRA (February 2009 to July 2011). We hypothesized that people who had a change in distance to the closest FQHC would have a decreased proportion of non-urgent ED visits at UI Hospital due to the availability of additional healthcare services for non-urgent needs at the new FQHC. Since we were limited to data that only included patients of the UI Hospital ED, we did not know if there were other sites that patients may have gone for health care needs such as FQHCs and other hospitals' EDs, so this study was exploratory.

This study is important because use of the ED for needs that could be seen at an FQHC is inefficient. In 2012, the average cost of a community health center visit ($150) was less than one-sixth the average cost of an ED visit ($978). (National Association of Community Health

Centers, 2015) If patients who lived in areas where FQHCs opened had less non-urgent ED utilization, then it could be beneficial to open FQHCs in high need areas to better manage patients and provide cost-savings.

B. Background

The overall objective of the ARRA was to provide funding to the individuals and communities most affected by the recession, including appropriations for FQHCs and other health care safety net providers- which are more essential to the generally lower income neighborhoods they serve during times of economic crisis. (Shin et al., 2010) Community health center patients are more racially and ethnically diverse and more likely to be uninsured or publicly insured than patients in other health care provider settings nationwide (Shi et al., 2013) and the centers are open to all- regardless of insurance status or the ability to pay. A simulation study that called providers posing as an uninsured patient found that FQHCs were 39% more likely to offer uninsured callers a visit for less than $75 than a primary care provider who was not housed in an FQHC. Median price for a visit was $60 for FQHC and $123 for a primary care provider who was not housed in a FQHC. (Saloner et al., 2014) FQHCs are located in high-need areas and tailor their services to fit the priorities of the community. (National Association of Community Health Centers, 2016)

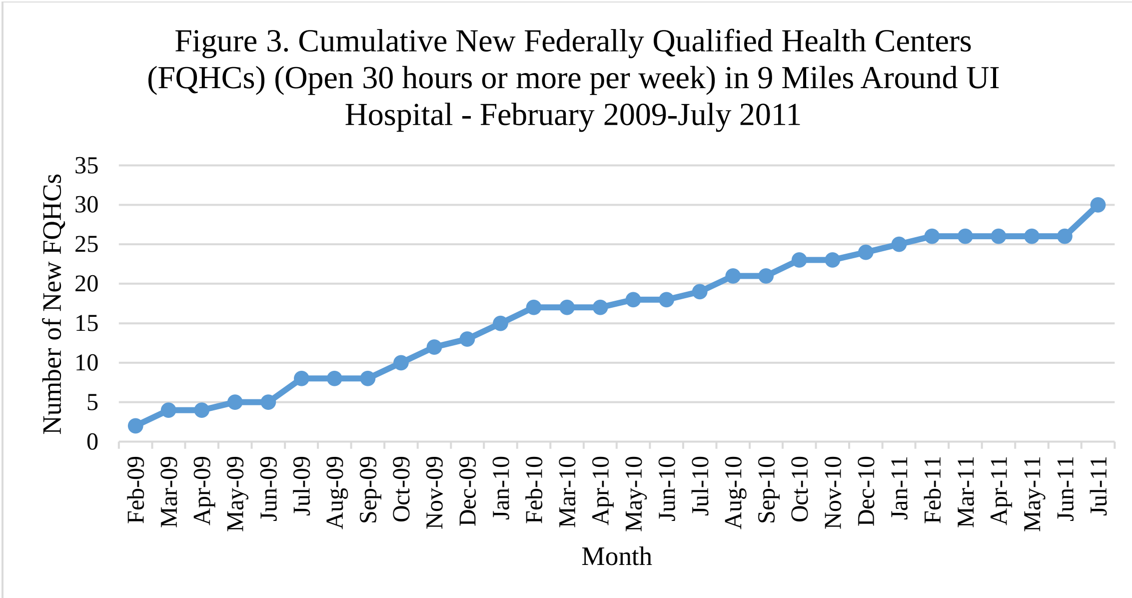
ARRA provided two billion dollars for community health centers, including $155 million in funding on March 2, 2009 for 126 new access points (NAP) for health centers. (Shin et al., 2010) NAPs enhanced access to care with new health center grantees or new locations for existing health centers, and allowed for the care of an estimated over 750,000 additional health center patients. (Shin et al., 2010) Other aspects of increased FQHC funding through ARRA included Increased Demand for Services (IDS) grants in March 2009, the Capital Improvement

Program (CIP) in June 2009, and the Facility Investment Program (FIP) in December 2009. (Shin et al., 2010)

During its initial implementation, it was estimated that close to three million new patients would be served by ARRA funding. Illinois had 37 IDS and NAP, and 40 FIP and CIP ARRA awards. (Shin et al., 2010) States with higher levels of unemployment received greater levels of health center funding. On average, health centers with states with the highest unemployment level (greater than 11%) received $35 million. Illinois received $80 million and was the sixth highest funded state. The estimated number of new patients supported by NAP grants in Illinois was 30,560, with 66,421 new patients from IDS funding- 31,032 of which were estimated to be uninsured patients. (Shin et al., 2010) In 2014, the Illinois FQHC population was 23% uninsured, 58% Medicaid patients, and 6% Medicare patients. 77% were at or below 100% of the poverty level, 34% were Hispanic, and 32% were African American. (National Association of Community Health Centers, 2016)

Around the time of ARRA, 29 full time (open 30 or more hours per week) FQHC sites opened in the nine mile radius surrounding UI Hospital (from 95 clinics in January 2009 to 124 clinics in July 2011). Because of Lake Michigan to the east, the 9 miles did not fully extend to the east. No sites closed. Figure 3 shows the cumulative number of new FQHC sites during this time period.

Access to FQHC was used for this analysis because these care sites are similar to EDs in the type of patients they will see. Primary care doctors can determine which insurance plans they see, but EDs and FQHCs see all patients regardless of insurance type or status. Compared to doctor’s offices that are not FQHCs, FQHCs are significantly more likely to schedule appointments for new Medicaid patients (56% vs 80%), while both types of providers are equally



likely to schedule new patient appointments for privately insured callers (85% vs. 84%). (Saloner et al., 2014)

C. **Literature Review**

Prior literature has largely found that increased primary care access decreases healthcare utilization, and a specific interest has focused on ED utilization and primary care access. A study by Lowe et al. (2009) compared ED utilization for Medicaid enrollees in primary care service areas (PCSAs), a geography composed of multiple zip codes, with primary care capacity less than the need and those with one to two times more capacity than needed. The authors found that those with primary care capacity equivalent or higher than the need had fewer ED visits than those areas with capacity below the need. (Lowe et al., 2009)

Other studies have explored the relationship between PCP availability and non-urgent health care usage, however these have been evaluated for specific patient populations. A cross-sectional study of pediatric patients in Washington, DC found that non-urgent ED visits were associated with low neighborhood income and low PCP spatial density- where the rate of non-urgent ED visits decreased by 9% for every 1 unit increase in PCP density. (Mathison et al., 2013) Mobley et al. (2006) found that for elderly patients (65+ years), availability of physicians did not affect admissions for ambulatory care sensitive conditions (ACSC), which are considered preventable with good preventive health care. (Mobley et al., 2006)

Studies have shown that greater FQHC availability is associated with fewer hospitalizations and decreased ED utilization. Using zip code level data over three years in the 1990s, one study showed that patients in underserved areas with FQHCs had 5.8 fewer preventable hospitalizations per 1,000 people than those areas without FQHCs. (Committee on Energy and Commerce, 2003) Greater community health center capacity has been found to reduce ED visits for low-income patients and uninsured patients. (Cunningham, 2006; Smith-Campbell, 2005) A county-level study in California from 2012 to 2015 found that a 1% increase in number of PCPs per 100,000 people was associated with a 0.36% decrease in ED visits, and a 1% increase in number of FQHCs per 100,000 people was associated with a statistically significant 0.01% decrease in preventable ED visits. (Cunningham and Sheng, 2018) This prior literature is helpful in determining our hypothesis for our study of opening of FQHCs on non-urgent ED utilization, but they are not without gaps in knowledge that our analysis helps to fill. These studies have looked at utilization based on patient self-report through surveys (Cunningham, 2006), have looked at descriptive changes from the establishment of only one community health center on ED utilization (Smith-Campbell, 2005), and have been based on county-level data (Cunningham and Sheng, 2018), which is geographically large and diverse.

Some literature has specifically explored distance as a form of access to care. One study, using a New York claims database, found that distance to the ED and primary care density had no significant effect on ED use in urban areas. Further distance to the closest ED was only associated with less ED use in suburban and rural areas, and the relationship between high primary care density was significantly associated with high ED use only in rural areas. (Lee et al., 2016)

One study (Chen et al., 2015) of all ED visits in South Carolina found that for patients with private insurance or who were uninsured, those who were further away from an ED had lower non-urgent ED usage. The authors found no significant relationship between distance to FQHC and non-urgent ED visits for Medicaid and uninsured patients. (Chen et al., 2015) The authors looked at all of South Carolina, without accounting for urbanicity differences, so it is possible that the urban and rural differences found by Lee et al. may have cancelled out any significance in their findings on this population. While Chen et al. looked at the distance to the closest FQHC, our analysis focused on a change in distance to the closest FQHC, signifying a new FQHC opening close to their home, which could have different implications than measuring distance. Furthermore, the authors' non-urgent ED utilization outcome was binary and included all levels of non-emergent and primary care treatable diagnoses, regardless of the level (probability greater than 0), whereas we include only "true" diagnoses in these categories (50-95%), with sensitivity testing with multiple values. (See further discussion of the NYU Algorithm (Billings et al., 2000a; Billings et al., 2000b) in the Dependent Variables section of our study.) Additionally, Chen et al. looked at the data at the zip code level, whereas our analysis is at the level of the patient's address. The authors looked at the closest FQHC for the quarter (2005-2010) that the patient presented to the ED, whereas we look at this data monthly (January 2009-July 2011).

Lastly, a recent study in Chicago found that patients had higher odds of preventable ED use if they lived in areas with lower access to primary care clinics and medically underserved areas. (Fishman et al., 2016) The study used 5 years of data, but only used cross-sectional primary care location data from a single year. This means that the analysis did not take into account changes in preventable ED use that may have occurred as areas increased or decreased in number of primary care locations over time.

While our analysis is descriptive and only uses data from one hospital, it features benefits which will add to the literature. The more precise geographic level of the study, compared to previous studies, allows for more precise determination of distance to new FQHCs. Compared to previous studies with an urban geographic setting, this study takes into account changes in location of FQHCs over time, rather than the distance to the closest FQHC at one point in time. Furthermore, although it is limited to data from one hospital, we used utilization data from medical records rather than self-reported utilization from a survey.

D. Methods

1. Study Setting

This study used data from the UI Hospital ED. The UI Hospital ED is a 24-hour facility that serves a diverse Chicago population. It is located within the Illinois Medical District and 21 of the 24 community areas in the UI Hospital primary service area (PSA) have a minority population greater than 75%. UI Hospital's patients mostly reside on the west, south, and southwest sides of Chicago. The communities in the hospital's primary service area include some of the poorest in the City of Chicago. (University of Illinois Hospital & Health Sciences System, 2016) The annual census of the ED is about 30,000 patients and 44,000 visits. Adult patients represent 75% of all ER visits, with 10% of patients 65 years or older. The ED's patient population is over half African American and a quarter Hispanic. During the study period, patient breakdown by insurance type was about 40% Medicaid, 15% Medicare, 30% private insurance, 13% uninsured, and 2% other (e.g. worker's compensation, patients in jail).

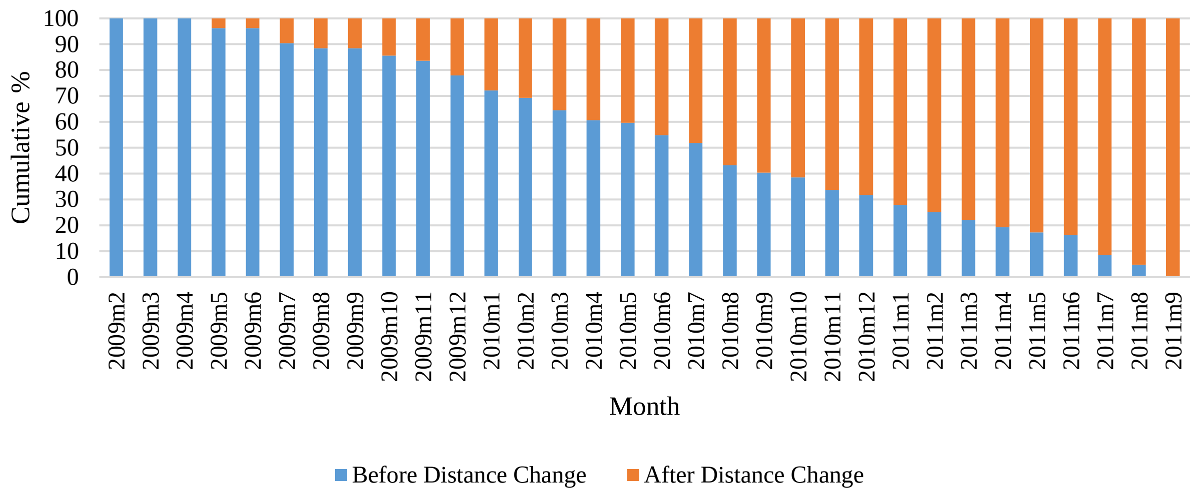
2. Sample

We looked at ED visits from January 2009 to December 2012 at UI Hospital in Chicago, IL. Patients were included in the study if they had at least one ED visit in January, February, or March 2009, were at least 18 years old, were uninsured or had Medicaid at the time of the ED visit, had an address within 7 miles of UI Hospital listed in their patient chart, had at least two visits from January 2009 to September 2011, and did not move during the study period. We also excluded visits where the patient did not have a discharge diagnosis listed in either the EMR or billing data. In most instances, this occurred when a patient presented to the ED but was immediately transferred to the emergency unit of the obstetric service of the hospital.

The sharp increase in number of FQHCs surrounding the hospital took place from February 2009 to July 2011. Although we used a 7 mile buffer for patient eligibility, we included all FQHCs within 9 miles of the ED to allow for an additional 2 miles of catchment outside of the 7 miles visit buffer around the ED. We used visits for these patients through December 2012 because we wanted to observe their utilization for a period after the openings of the new FQHCs. We excluded visits in the month of June 2009 because of an issue with the EMR data for that month. The total number of eligible patients for the study was 1,022, with 5,963 total visits during the full study period of January 2009 to December 2012.

Figure 4 shows the cumulative percentage of patients with a change in distance to closest FQHC by month for patients who had a distance change. The month of their distance change was determined based on their first return visit to the ED (after initial eligibility visit in January, February, and/or March 2009), for which the distance to closest FQHC changed. In all cases, the distance decreased because no FQHCs closed during this time period. Patients who came to the ED in August or September 2011 with a distance change were included in the patients with distance change group because there were no new FQHCs in August or September 2011. FQHC openings and ED visits were collapsed to the month level. For analysis purposes, this meant that, for example, we assumed that a July clinic opening occurred on July 1.

Figure 4. Timing of Distance Change for Patients with Change of Distance to Closest Federally Qualified Health Center (FQHC) (Cumulative Percent (%) of Patients Who Changed Distance per Month)



Study data came from two sources. First, data was pulled through a batch report directly from Cerner (Cerner Corporation, Kansas City, MO) electronic medical records (EMR). The EMR data included all demographic variables of interest (race, ethnicity, age, gender, insurance type, arrival date to ED, and home address). Second, billing data from Wolcott, Wood, and Taylor, Inc. (WWT) was used. The billing data was matched to EMR data because billing data had more complete and accurate International Classification of Diseases, Ninth Revision (ICD-9) data. The process for determining a diagnosis code is that the physicians document in the chart the patient signs and symptoms along with the patient diagnosis. Then professional coders provide the coding of the ICD-9 code of the diagnosis and then the encounter is sent to the billing company (WWT) for submission to the payer. Therefore, the ICD-9 codes in the billing data were prioritized over those in the EMR data. The ICD-9 codes were only used from the EMR data if the code was missing from the billing data.

It was possible for a visit to have more than one ICD-9 discharge diagnosis code and we used the primary diagnosis code. The ICD-9 codes are listed in order from the most significant reason for the visit to the least significant reason for a given visit. Therefore, by using the primary diagnosis code, this was the main reason for the visit.

Each patient had a unique medical record number (MRN) as well as a date of service in both the billing and EMR data. In order to match patients' demographic characteristics to the appropriate visit, we merged visit records from the EMR to billing records using a merging key of MRN+date of service. It was possible for a patient to have more than one MRN listed in the EMR. This could be caused by a patient that is unconscious at time of arrival to the ED and is registered as a John or Jane Doe; a patient that uses multiple aliases; or a registration error, where the clerk fails to locate the patient's record. As a result, the MRN+date merging key resulted in some visits for these patients having no match with the billing data. Therefore a merging key was constructed of the patient's last name+first name+date of service.

Additionally, if a patient was missing an insurance type in the EMR data, we used the patient's insurance from the billing data.

All data cleaning and analysis were completed using Stata Version SE 14.2 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

3. Covariates

It was important to control for the observable variables that we had available in the data because of their potential impact on ED utilization in order to avoid omitted variable bias. We controlled for age, gender, race, ethnicity, insurance type, and zip code level poverty rate. Differences in healthcare utilization amongst these groups are given below. We also controlled for seasonal and historical time variables of month and year of visit.

a. Age

Nationally, in 2013, 25-44 year olds made up the highest percentage of ED visits (27.5%), followed by 45-64 year olds (23.3%), people under 15 years (18.2%), people 65 years and older (15.9%), and then 15-24 year olds (15.1%). However, people 65 years and older had the highest number of visits per 100 persons per year with 47.8 visits, followed by 15-24 years (45.9), 25-44 years (44.1), under 15 years (38.9), and 45-64 years (36.9). (Rui et al., 2016) For people 65 years and older, this rate was more than twice the average (282.0), at 588.5 visits per 100 persons per year, and this group represented 29.9% of all office visits. For 45 to 64 year olds, the rate was also above the average, at 330.4 visits, and represent 30.9% of all office visits. All other age groups had lower than the average rate. (Rui et al., 2017) Overall, elderly patients tend to have more medical needs than younger people, so they have higher rates of medical use. In 2014 Illinois FQHCs, children made up 36.7% of visits, adults 18 to 64 years old made up

58.1% of visits, and adults 65 years and older made up 5.2% of visits. (Health Resources & Services Administration, n.d.)

b. Gender

Compared to males, females tend to be significantly more likely to have 5+ ED visits annually for non-emergent needs. (Behr and Diaz, 2016) In 2013, the number of visits per 100 persons per year was 45.9 for women, compared to 37.7 for men. (Rui et al., 2016) Females also had more physician office visits than men, with 57.5% of visits in 2014. Females made 317.1 visits per 100 persons per year compared to 245.4 for men. (Rui et al., 2017) Similarly, for Illinois FQHCs in 2014, 66% of all patients 15 to 64 years old were female. (Health Resources & Services Administration, n.d.) The higher overall utilization of healthcare (ED, physician office, and FQHC) by females suggests that this is an important variable to control for in our models.

c. Race

Literature has shown that black patients were significantly more likely to have 3+ ED visits for non-emergent needs compared to other races. (Behr and Diaz, 2016) Nationally, in 2013, white patients made up a higher percentage of ED visits (74.1%) than black patients (22.3%) or other (3.6%). However the number of visits per 100 persons per year was much higher for black patients (72.2) than white patients (39.9). (Rui et al., 2016) In 2014, white patients, at 85.1% and 309.8 visits per 100 persons per year, made more physician office visits than black patients (9.2% and 198.7 visits per 100 persons per year) or other races (5.7% and 169.4 visits per 100 persons per year). (Rui et al., 2017) In 2014, the racial/ethnic breakdown of FQHC users in Illinois was 41.6% black, 35.3% Hispanic, and 32.9% non-Hispanic white. (Health Resources & Services Administration, n.d.)

d. <u>Ethnicity</u>

ED and outpatient visits have differed by ethnicity, where Hispanic patients have lower rates of ED and outpatient visits than non-Hispanic patients. In 2013, Hispanic patients made up 15.3% of all ED visits in the US, with a rate of 37.3 visits per 100 persons per year, compared to non-Hispanic patients with 84.7% of visits and 42.9 visits per 100 persons per year. (Rui et al., 2016) For physician office visits in 2014, Hispanic patients made up 13.3% of all visits, with a rate of 215.2 visits per 100 persons per year, compared to non-Hispanic patients with 86.7% of visits and 296.2 visits per 100 persons per year. (Rui et al., 2017)

e. <u>Insurance Type</u>

In the US in 2013, ED patients had private insurance in 36.0% of visits, Medicaid or CHIP in 30.0% of visits, Medicare in 19.6% of visits, and no insurance for 15.1% of visits. (Rui et al., 2016) Over half of physician office visits in 2014 were by patients with private insurance (59.9%), followed by Medicare patients (26.8%), Medicaid patients (12.9%), and patients with no insurance (5.0%) (8.2% had other or unknown insurance). (Rui et al., 2017) Studies have shown that patients with Medicare or Medicaid are 2.6 times more likely to have 5+ ED visits in a year for non-emergent needs compared to other insurance types. (Behr and Diaz, 2016)

Adults with Medicaid were most likely to report that their ED visit was due to the seriousness of their problem and those with private insurance were most likely to have used the ED because their doctor's office was not open. (Gindi et al., 2016) Uninsured adults were significantly more likely than adults with private insurance or Medicaid to have visited the ED because of a lack of access to other providers. (Gindi et al., 2016) However, adults with Medicaid and Medicaid + Medicare whose last ED visit did not result in a hospitalization were more likely to seek care in the ED because of barriers to accessing outpatient services as compared to those with private insurance. (Capp et al., 2014)

We limited the analysis to uninsured and Medicaid patients because these are the biggest utilizers of FQHCs in Illinois (81.8% in 2014). (Health Resources & Services Administration, n.d.) They are also a patient population that is more limited in their choices for care.

f. Zip Code Level Poverty Rate

We used the variable "Income in the past 12 months below poverty level" from American Community Survey data (U.S. Census Bureau) to determine zip code-level poverty rate. We calculated the poverty rate using the number of people in each zip code with income in the past 12 months below poverty level divided by the total number of people living in each zip code using the 5-year ACS 2007-2011.

While it was important to control for this variable to account for potential differences in patients from neighborhoods with different poverty rates, it was especially important because FQHC locations are targeted for low-income neighborhoods, so the poverty rate of a zip code might impact whether an area gets a new FQHC and areas with higher poverty might have more FQHC demand. In 2014, of patients seen in Illinois FQHCs, 97% were at or below 200% of the poverty level and 77% were at or below 100% of the poverty level. (Health Resources & Services Administration, n.d.) We also clustered all standard errors by zip code in order to account for similar characteristics, such as poverty rate, amongst the zip code in which the patient resides.

g. Month

To account for seasonality, a dummy variable for each month (January-December) was included in each model.

h. <u>Year</u>

To account for historical difference by year, a dummy variable for each year (2009-2012) was included in each model.

i. <u>Patient Characteristics in the Sample</u>

One thousand twenty-two (1,022) unique patients fit study eligibility criteria and were seen in the ED in January, February, and/or March 2009. Of these unique patients, the distance to the closest FQHC changed for 106 patients (10.4%), meaning a new FQHC opened near them, which became their closest center. Of these patients, 104 patients had 1 distance change and 2 patient had two distance changes. Eligible patients lived in 37 unique zip codes total, and patients with a change in distance lived in 17 zip codes. In our sample, there were 382 patients who presented to the UI Hospital ED multiple times in a given month. During the study period, the average number of ED visits per month was 1.2, with a range of 1 to 7 visits per month. The average number of visit that patients presented to the ED over the study period was 5.8, with a range of 2 visits to 76 visits.

Table VI shows the demographic characteristics, at the time of the first ED visit in the study period, for patients who did not have a change in distance to closest FQHC and those who did have a change in closest FQHC. There were significantly more black patients in the group that did not have a closer FQHC (74.2% compared to 50.0%), and significantly more Hispanic patients in the group that did have a closer FQHC (43.3% compared to 18.8%). The percent of residents below the poverty level at the zip code level was significantly higher for the patients who did not have a change in FQHC distance compared to those who did have a change in distance (30.7% compared to 26.8%, respectively). Based on these findings, it is possible that FQHCs may have already existed in the lowest income neighborhoods, and the new FQHCs opened in neighborhoods that had high poverty rates, but had less poverty than neighborhoods where FQHCs already existed before the increase from ARRA.

TABLE VI. CHARACTERISTICS FOR PATIENTS WHO DID NOT HAVE CHANGE IN FEDERALLY QUALIFIED HEALTH CENTER (FQHC) DISTANCE COMPARED TO PATIENTS WHO HAD CHANGE IN FQHC DISTANCE AT TIME OF FIRST EMERGENCY DEPARTMENT VISIT (JANUARY, FEBRUARY, OR MARCH 2009)

Variable	Patients Who Did Not Have Change in FQHC Distance (N=916)	Patients Who Had Change in FQHC Distance (N=106)	p-value
Race			
% Black	74.2	50.0	**0.000**
% White	4.3	4.7	0.827
% Other	21.5	45.3	**0.000**
% Hispanic	18.8	43.3	**0.000**
% Female	73.3	66.0	0.109
Age			
% 18-29 years	36.2	28.3	0.106
% 30-44 years	31.9	38.7	0.157
% 45-64 years	29.8	29.2	0.905
% 65 years and older	2.1	3.8	0.264
Insurance Type			
% Medicaid	75.9	76.4	0.902
% Uninsured	24.1	23.6	0.902
2011 Poverty Rate for Zip Code, Mean (Standard Deviation)	30.7 (7.7)	26.8 (5.8)	**0.000**

4. <u>Independent Variable of Interest</u>

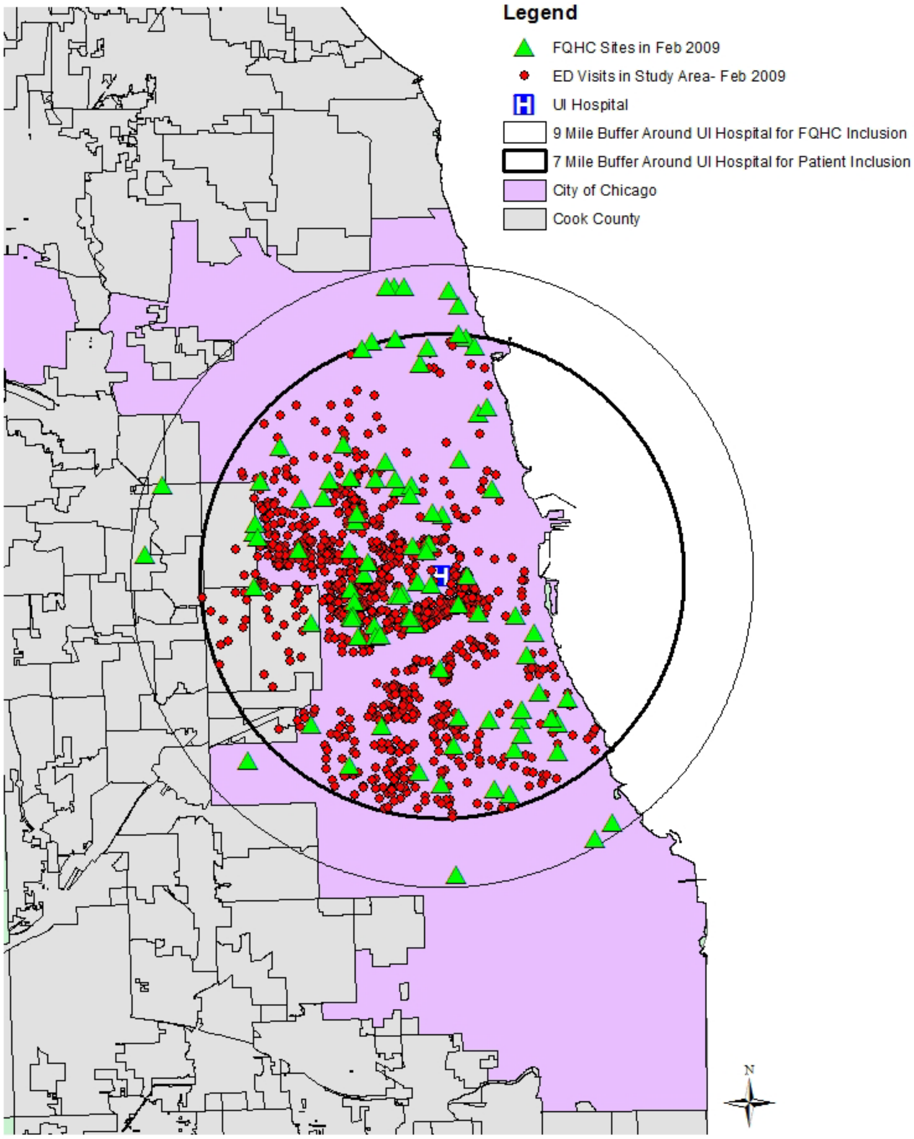
The independent variable of interest for this analysis was the distance to closest FQHC, in quarter miles. If a patient had a change in distance to the closest FQHC, it meant that there was a FQHC that opened closer to the patient's home, suggesting increased primary care capacity for people with Medicaid and no insurance in their neighborhood.

In order to determine distance to closest FQHC, all patient addresses were extracted from the patient chart and geocoded in ArcGIS. Based on literature that says average travel distance to the ED is about 2 to 7 miles (Chan et al., 2006; Lee et al., 2016), we created a 7 mile buffer around the hospital to capture the bulk of the ED patients and limited visits to those patients who lived within this buffer.

We obtained site addresses of all FQHCs in Illinois using Uniform Data System (UDS) data from the Health Resources & Services Administration (HRSA), who oversees the health center program, through a Freedom of Information Act request. Additionally, we obtained the operational date and termination date of all sites in Illinois that opened or closed between 2009 and 2011. Since the UDS data included weekly hours of operation for each FQHC, we limited our FQHCs to those open at least 30 hours per week. We included all FQHCs within 9 miles of the ED (allowing for an additional 2 miles of catchment outside of the 7 miles visit buffer around the ED). We used ArcGIS mapping software to calculate the distance to the closest FQHC for each patient for each month that the patient had a visit to the UI Hospital ED from January 2009 to September 2011. We used the patient's medical record to determine the patient's ED utilization for that month. Distances were determined using ArcGIS in feet, but we converted the distance into quarter miles for ease of interpretation. Because we were interested in using utilization data through December 2012, and none of the patients in the study moved residences, we carried forward the distance to closest FQHC from the last visit during the January 2009-September 2011 period through the end of the study period (December 2012). Figure 5 shows an example map for the February 2009 ED visits and FQHC locations in the study area. Figure 19, Appendix B shows maps of new clinics by month.

The average distance to the closest FQHC for visits by patients with no change in distance was 1.7 quarter miles, with a minimum of 0.4 and a maximum of 7.2 quarter miles. The average distance for visits by patients before a distance change was 2.7 quarter miles, with a

Figure 5. Example Map: February 2009 Emergency Department Visits and Federally Qualified Health Center (FQHC) Locations in Study Area



range of 0.7 quarter miles to 5.6 quarter miles. The average distance to the closest FQHC for visits by patients after a change in distance was 1.8 quarter miles, with a range of 0.2 to 4.5 quarter miles.

5. Dependent Variables

The outcome of interest was proportion of non-urgent ED visits out of all ED visits. We measured this using two algorithms- the NYU Algorithm (Billings et al., 2000b) and the Emergency Severity Index (ESI). (Gilboy et al., 2012)

a. NYU Algorithm

The NYU Algorithm is a validated measure (Ballard et al., 2010) that has been used by much published literature to characterize the urgency of ED visits (Billings and Raven, 2013; McCormack et al., 2016). The algorithm was developed by a group of emergency medicine and primary care physicians to categorize ED visits into four categories based on level of urgency. Using a sample of complete ED records from 1994 and 1999, the creators reviewed 5,700 patient medical records from six Bronx, New York hospitals to determine an algorithm that uses patient discharge ICD-9 and ICD-10 codes to categorize each visit. (Billings et al., 2000b)

The reviewers used patient information on initial complaints, ED procedures performed, ED resources used, vital signs, age, medical history, and discharge diagnosis. In the first step of the algorithm, patients were categorized as Emergent if they needed contact with the medical system within 12 hours or Non-Emergent if not. This was determined based on initial complaint, age, gender, temperature, respiratory rate, pulse rate, symptom duration, and comorbidities. (Billings et al., 2000b)

In the second step of the algorithm, the Emergent cases were then categorized as Primary Care Treatable if care could have been provided in a non-ED setting, or ED Care Needed otherwise. This was based on the procedures and resources used in the ED. Patients were categorized as Emergent- ED Care Needed if they used resources not typically available in a non-ED setting (e.g., CAT scan). Patients were categorized as Emergent- Primary Care Treatable if they did not use resources in the ED or used those generally available in a non-ED setting (e.g. routine blood test). If the initial complaint alone justified ED use (e.g. chest pain or gastrointestinal obstruction), then the patient was categorized as Emergent- ED Care Needed, regardless of resources used. (Billings et al., 2000b)

In the third step of creating the algorithm, the chief complaints were paired with the eventual discharge diagnosis to define the percent of diagnoses that belonged in the step 1 and step 2 categories. For example, a patient with a diagnosis of abdominal pain who only used resources in the ED that are available in a non-ED setting could be classified as Emergent- Primary Care Treatable. However, a patient could be classified as Emergent- ED Care Needed if he came to the ED with a chief complaint of chest pain, was treated for a possible heart attack, and had a discharge diagnosis of abdominal pain. The percentages of discharge diagnoses that fell into each category composed the probabilistic percentage for each diagnosis code. (Billings et al., 2000b)

Finally, in the fourth step of creating the algorithm, Emergent- ED Care Needed cases were classified as either Preventable/Avoidable or Not Preventable/Avoidable. A case was considered to be preventable if episodes of the condition could have been more effectively managed with timely and effective outpatient care. This determination was based on the ambulatory care sensitive condition classification scheme that was previously developed by the authors for use in analysis of hospital discharges. (Billings et al., 2000b)

In summary, the algorithm breaks visits into four categories based on discharge diagnosis code (ICD-9 and ICD-10) (Billings et al., 2000b):

1. <u>Non-Emergent (NE)</u>– “The patient’s initial complaint, vital signs, medical history, and age indicated that immediate medical care was not required within 12 hours.”; (Billings et al., 2000a)
2. <u>Emergent/Primary Care Treatable (PCT)</u>- “Treatment was required within 12 hours, but care could have been provided in a primary care setting. The complaint did not require continuous observation, and no procedures were performed or resources used that are not available in a primary care setting (e.g., CAT scan or certain lab tests).”; (Billings et al., 2000a)
3. <u>Emergent - ED Care Needed - Preventable/Avoidable (EDP)</u> – “Emergency care was required based on the complaint or procedures or resources used, but the emergent nature of the condition was potentially preventable or avoidable if timely and effective primary care had been provided (e.g., flare-ups of asthma, diabetes, or congestive heart disease).”; (Billings et al., 2000a)
4. <u>Emergent - ED Care Needed - Not Preventable/Avoidable (EDNP)</u> – “Emergency care was required and primary care treatment could not have prevented the condition (e.g., trauma, appendicitis, or heart attack).” (Billings et al., 2000a)

Additionally, diagnoses can be categorized as mental health related, alcohol related, substance abuse related, injury, or unclassified if they do not fall into any categories (e.g. fitting/adjusting of medical equipment, cholera, or suicidal ideation).(Billings et al., 2000b)

Our outcomes focused on the categories of Non-Emergent (NE) and Primary Care Treatable (PCT) because these were the categories where the algorithm suggests that ED care is not needed.

Diagnostic categories are generally not clear-cut in all cases. Therefore, the algorithm reflects potential uncertainty and variation by assigning cases on a percentage basis. Examples of the categorization of some common diagnoses using the algorithm are found in Table VII.

TABLE VII. EXAMPLES OF NEW YORK UNIVERSITY (NYU) ALGORITHM PROBABILITIES FOR A SAMPLE OF DIAGNOSES

Diagnosis	ICD-10[a] Code	% Emergency Department Care Needed, Not Preventable	% Emergency Department Care Needed, Preventable/ Avoidable	% Emergent, Primary Care Treatable (PCT)	% Non-Emergent (NE)
Unspecified abdominal pain	R10.9	33%	0%	67%	0%
Shortness of breath	R06.02	60%	0%	40%	0%
Chest pain, unspecified	R07.9	68%	0%	32%	0%
Streptococcal pharyngitis (Strep throat)	J02.0	0%	6%	28%	66%
Cough	R05	12%	0%	24%	65%
Dorsalgia, unspecified (Back pain)	M54.9	11%	0%	15%	74%
Nausea	R11.0	18%	0%	24%	59%
Otitis media, unspecified, unspecified ear (Ear infection)	H66.90	0%	4%	59%	37%
Headache	R51	13%	0%	9%	78%
Plantar wart	B07.0	0%	0%	0%	100%
Carpal tunnel syndrome, unspecified upper limb	G56.00	0%	0%	0%	100%
Ocular pain, unspecified eye	H57.10	0%	0%	100%	0%
Heartburn	R12	0%	0%	100%	0%

[a]ICD-10= International Classification of Diseases, 10th Revision

A 2013 systematic review of 26 articles on visiting the ED for non-urgent conditions found that no two articles had the same definition of non-urgent visits. (Uscher-Pines et al., 2013) Even other studies that have used the NYU Algorithm have used it differently. For example, the previously referenced Chen et al. (2015) used continuous probabilities for each category for their analysis, as well as a categorical binary variable equal to 1 if either the NE or PCT probability was greater than 0. Fishman et al. (2016) created a binary non-emergent variable where non-emergent was if the diagnosis was 100% NE/PCT and emergent was if the diagnosis was 100% Not Preventable/Avoidable.

To account for the many ways to determine if a visit was non-urgent, we used the continuous mean probability value for NE, PCT, and NEPCT diagnoses and also created multiple thresholds for each non-urgent category (NE, PCT, and NEPCT) at 50-95% probability that the diagnosis was within the category. (See Table VIII) When we collapsed the data by patient-month, we used the mean continuous probability for each month to create binary variables for each threshold. If the mean probability for that patient-month was at or above the threshold, the binary variable was 1. If it was below the threshold, the binary variable was 0. For example, if the mean PCT probability for a patient-month was 0.62, then the PCT50 and PCT60 would be 1, but PCT70-PCT95 would all be 0. This allowed us to explore the sensitivity of findings to varying probability thresholds for non-urgent diagnoses.

While the ED NYU Algorithm is widely utilized to determine urgency of ED visits in research studies, it is not without faults. The retrospective nature of a diagnosis has different implications than a patient's chief complaint that brings them to the ED. As a result, the limitations of diagnosis-based performance measures in emergency medicine has been increasingly recognized. While diagnosis-based measures are advantageous in that they are readily available in large-scale patient data, such as claims data, they fail to measure risk stratification of symptoms. Elements of chief complaint measures that make them difficult for use as a performance measurement is that they are not standardized, so there is a lack of

TABLE VIII. OUTCOME VARIABLE DETAILS FOR CHAPTER II STUDY

j	**Outcomes**	Variable Information
1 2 3 4 5 6	NE50 NE60 NE70 NE80 NE90 NE95	Binary value (0/1), where 1 if the continuous mean probability of the diagnosis for the non-emergent (NE) category was at or above the threshold of interest, and 0 if below the threshold, based on the NYU Algorithm. NE50 was where the ICD diagnosis code for the patient-month had a NE mean value of 50% or greater. Cutoff sensitivities were explored by changing the NE probability to ≥ 60% (NE60), 70% (NE70), 80% (NE80), 90% (NE90), and 95% (NE95).
7 8 9 10 11 12	PCT50 PCT60 PCT70 PCT80 PCT90 PCT95	Binary value (0/1), where 1 if the continuous mean probability of the diagnosis for the primary care treatable (PCT) category was at or above the threshold of interest, and 0 if below the threshold, based on the NYU Algorithm. PCT50 was where the ICD diagnosis code for the patient-month had a PCT mean value of 50% or greater. Cutoff sensitivities were explored by changing the PCT probability to ≥ 60% (PCT60), 70% (PCT70), 80% (PCT80), 90% (PCT90), and 95% (PCT95).
13 14 15 16 17 18	NEPCT50 NEPCT60 NEPCT70 NEPCT80 NEPCT90 NEPCT95	Binary value (0/1), where 1 if the continuous mean probability of the diagnosis for the non-emergent+primary care treatable (NEPCT) category was at or above the threshold of interest, and 0 if below the threshold, based on the NYU Algorithm. NEPCT50 was where the ICD diagnosis code for the patient-month had a NEPCT mean value of 50% or greater. Cutoff sensitivities were explored by changing the NE+PCT probability to ≥ 60% (NEPCT60), 70% (NEPCT70), 80% (NEPCT80), 90% (NEPCT90), and 95% (NEPCT95).
19	NE	Continuous variable- probability values (%) for Non-Emergent (NE) category. This was averaged by month if a patient had multiple visits in a month.
20	PCT	Continuous variable- probability values (%) for Primary Care Treatable (PCT) category. This was averaged by month if a patient had multiple visits in a month.
21	NEPCT	Continuous variable- probability values (%) for Non-Emergent plus Primary Care Treatable (NE+ PCT). This was averaged by month if a patient had multiple visits in a month.
22	ESI	Continuous variable of Emergency Severity Index assigned at ED visit, on a scale of 1 to 5, where 1 is most urgent and 5 is least urgent. This was averaged by month if a patient had multiple visits in a month.

consensus on what terms to use and the level of granularity to use for conditions. They also vary across different EDs, nurses, and visits. (Griffey et al., 2015) Standardization of chief complaint terminology has been recommended by a Society for Academic Emergency Medicine consensus panel. (Haas et al., 2008) Additionally, while diagnosis codes are generally available in patient data, compilation of chief complaint data can be expensive, time consuming, and often require chart abstraction. (Griffey et al., 2015) Because of these limitations, we also explored Emergency Severity Index (ESI) as an outcome in the analysis.

b. Emergency Severity Index (ESI)

In addition to the NYU Algorithm, which uses diagnosis codes that are determined at the conclusion of the visit, we modelled the data using ESI as an outcome. The ESI is a tool used by ED nurses to triage patients when they present to the ED and identify patients who cannot wait to be seen. It takes into account both acuity and resource needs. (Gilboy et al., 2012) The ESI has five levels, where smaller numbers signify a more urgent patient. One (1) is resuscitation (most urgent), 2 is emergent, 3 is urgent, 4 is less urgent, and 5 is non-urgent. Determination of the ESI level is based on four questions: "1. Does the patient require immediate life-saving care?, 2. Is this a patient who shouldn't wait?, 3. How many resources (e.g. labs, imaging) will this patient need?, and 4. What are the patient's vital signs?" (Gilboy et al., 2012) If the patient is dying, they are given a level of 1. If they are not dying but shouldn't wait, they are given a 2. If it is ok for the patient to wait, the patient requires many resources, and they have no dangerous vital signs, they receive a score of 3. If the patient requires many resources and has dangerous vital signs, a score of 2 can be considered. If the patient can wait and needs one resource, they get a score of 4, and if they need no resources, they get a score of 5. (Gilboy et al., 2012) Use of the ESI allowed us to look at the urgency of the visit at the time of the patient's arrival to the ED, which may be a better indicator than the NYU algorithm of the initial urgency of the condition and/or the perceived severity of the condition by the patient. For our analysis, we used a continuous mean value of the ESI at the patient-month level (Table VIII).

E. <u>Research Design</u>

We used the following linear regression models, at the patient-month level, to examine the association between distance to closest FQHC and non-urgent ED utilization, controlled for patient covariates:

$$(4) \quad Y_{it}^{j} = \beta_0^{j} + \beta_1^{j} Distance_{it} + (\beta_2^{j})' X_{it} + \epsilon_{it}^{j}$$

All data were collapsed from the day-month-year visit level to the month level for each patient. In Equation (4), each j represented a different dependent variable (see Table VIII). For continuous outcomes (j=19-22), the collapsed patient-month outcomes were the mean for all visits in that month. For binary outcomes (j=1-18), we created a binary variable (0/1) based on whether the continuous mean probability for NE, PCT, and NEPCT was at or above the threshold of interest. If it was at or above the threshold, it was coded as 1 and if it was below the threshold, it was coded as 0. Since we collapsed the data at the month level for each patient, it was possible for a patient to have different demographic characteristics within the same month (for example, a patient could have been uninsured and with Medicaid insurance within the same month). As a result, we used the demographic characteristics of the first non-missing value for each month. In the model, $Distance_{it}$ was the independent variable of interest, which was a continuous variable of the distance to the closest FQHC. In the model, each outcome was notated as *j*, each individual as *i*, and each month as *t*. Standard errors were clustered by zip code to account for similarities between zip codes.

We ran the model two ways. First, we ran the model with patient fixed effects, and second we ran the model as pooled, cross-sectional data. Since we had longitudinal data, we could explore within-patient changes in patients who had a distance change over time, using the patient fixed effects model. We also wanted to look at associations between distance to closest FQHC and non-urgent ED utilization across patients, so we also ran models using pooled, cross-sectional data without patient fixed effects.

The following time-varying covariates (X) were controlled in all models with patient fixed effects: age in years (continuous), insurance type (Medicaid, uninsured), month of visit (January-December), and year of visit (2009, 2010, 2011, or 2012).

The following covariates were controlled in all pooled cross-sectional models: race (black, white, other), ethnicity (Hispanic, non-Hispanic), age in years (continuous), gender (male, female), insurance type (Medicaid, uninsured), zip code level poverty rate (continuous), month of visit (January-December), and year of visit (2009, 2010, 2011, or 2012).

F. <u>Results</u>

Table IX shows the proportion of non-urgent outcome variables for patient-months without a distance change or before a distance change to the closest FQHC compared to those after a change in distance to closest FQHC, without controlling for patient-level covariates. There was one significant difference between these groups, which was a significantly higher mean proportion of PCT probability for patients without distance change than patients with distance change.

TABLE IX. PROPORTION OF NON-URGENT EMERGENCY DEPARTMENT VISIT OUTCOME VARIABLES FOR PATIENT-MONTHS WITHOUT DISTANCE CHANGE OR BEFORE DISTANCE CHANGE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER COMPARED TO PATIENT-MONTHS AFTER DISTANCE CHANGE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER

Outcome Variable	Patient-Months Without Distance Change or Before Distance Change (N=4,796 patient-months)	Patient-Months After Distance Change (N=295 patient-months)	p-value
% of Diagnoses with Non-Emergent Probability ≥50%	24.8	27.9	0.228
% of Diagnoses with Non-Emergent Probability ≥60%	22.9	23.5	0.833
% of Diagnoses with Non-Emergent Probability ≥70%	16.6	17.0	0.849
% of Diagnoses with Non-Emergent Probability ≥80%	5.7	5.8	0.933
% of Diagnoses with Non-Emergent Probability ≥90%	3.1	3.7	0.565
% of Diagnoses with Non-Emergent Probability ≥95%	2.6	2.7	0.893
Mean Non-Emergent Probability for All Visits	20.6	23.2	0.182
% of Diagnoses with Primary Care Treatable Probability ≥50%	19.5	17.0	0.289
% of Diagnoses with Primary Care Treatable Probability ≥60%	17.2	15.3	0.396
% of Diagnoses with Primary Care Treatable Probability ≥70%	4.8	3.4	0.270
% of Diagnoses with Primary Care Treatable Probability ≥80%	3.9	3.4	0.649
% of Diagnoses with Primary Care Treatable Probability ≥90%	0.9	1.4	0.372
% of Diagnoses with Primary Care Treatable Probability ≥95%	0.9	1.4	0.372
Mean Primary Care Treatable Probability for All Visits	25.3	22.2	**0.048**
% of Diagnoses with Non-Emergent + Primary Care Treatable Probability ≥50%	47.0	49.3	0.435
% of Diagnoses with Non-Emergent + Primary Care Treatable Probability ≥60%	44.7	48.3	0.223
% of Diagnoses with Non-Emergent + Primary Care Treatable Probability ≥70%	30.8	33.0	0.425
% of Diagnoses with Non-Emergent + Primary Care Treatable Probability ≥80%	28.4	27.6	0.756
% of Diagnoses with Non-Emergent + Primary Care Treatable Probability ≥90%	14.1	15.0	0.684
% of Diagnoses with Non-Emergent + Primary Care Treatable Probability ≥95%	8.5	8.8	0.852
Mean Non-Emergent + Primary Care Treatable Probability for All Visits	45.9	45.5	0.846
Emergency Severity Index (ESI)[a]	3.3	3.3	0.132

[a] Where 1 is most urgent and 5 is least urgent.

Tables X through XII use patient fixed effects to explore the association of change distance to closest FQHC on non-urgent ED utilization the same patient, controlled for time-varying patient covariates. Table X shows the association between distance to closest FQHC on probability of having a NE, PCT, and NEPCT ED visit at various cut points (50% to 95% for each outcome type). Most of the NE visit thresholds had a positive sign, whereas most of the PCT and NEPCT results had a negative sign. However, there were no significant findings for these outcomes.

TABLE X. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – PATIENT FIXED EFFECTS-
JANUARY 2009-DECEMBER 2012 (N=5,091 PATIENT-MONTHS)[a,b,c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	0.0234	0.0375	0.0271	0.0190	-0.00142	0.00127
	(0.0347)	(0.0287)	(0.0273)	(0.0137)	(0.00872)	(0.00692)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	-0.0137	-0.00190	-0.0221	-0.0246	-0.0166	-0.0166
	(0.0303)	(0.0329)	(0.0225)	(0.0235)	(0.00920)	(0.00920)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	-0.0203	-0.0151	-0.0275	-0.000538	0.00438	-0.0109
	(0.0296)	(0.0288)	(0.0234)	(0.0279)	(0.0240)	(0.0255)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.

Table XI shows the association between distance to closest FQHC and continuous mean probability of NE, PCT, and NEPCT ED visits. There were no significant findings. Again, the sign for the NE coefficient was positive and the signs for the PCT and NEPCT coefficients were negative. Table IX showed that the mean probability for PCT visits was significantly lower for visits by patients with a change in distance to closest FQHC, without controlling for patient characteristics. The continuous mean for PCT in Table XI had a negative sign, however this finding was not significant when controlling for patient covariates.

TABLE XI. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- JANUARY 2009-DECEMBER 2012 (N=5,077 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	0.0115	-0.0140	-0.00241
	(0.0232)	(0.0253)	(0.0171)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

Table XII shows the association of change in distance to closest FQHC on the mean ESI for ED visits. The sign on the coefficient was negative but the finding was not significant.

TABLE XII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX (ESI) FOR EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- JANUARY 2009-DECEMBER 2012 (N=5,074 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	-0.00779 (0.0296)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.
[d] Where 1 is most urgent and 5 is least urgent

Tables XIII through XV use pooled cross-sectional data, without fixed effects, to explore the association of change distance to closest FQHC on non-urgent ED utilization across patients, controlling for patient characteristics. Table XIII looks at the association between distance to closest FQHC and probability of having a NE, PCT, or NEPCT ED visit across all patients. Almost all NE, PCT, and NEPCT thresholds had a negative sign for this association, however no relationships were significant.

Table XIV shows the association between distance to closest FQHC on continuous mean probability of NE, PCT, and NEPCT ED visits, controlled for patient covariates. The coefficient signs for NE and NEPCT were negative and the sign for PCT was positive, however no findings were significant for these relationships.

TABLE XV shows the association between distance to closest FQHC and mean ESI for ED visit, which was found to not be a significant relationship.

TABLE XIII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – POOLED CROSS-SECTIONAL ANALYSIS
JANUARY 2009-DECEMBER 2012 (N=4,510 PATIENT-MONTHS)[a, b, c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	-0.00113	-0.00133	0.00101	-0.00141	-0.00152	-0.00211
	(0.00812)	(0.00765)	(0.00679)	(0.00413)	(0.00241)	(0.00187)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	-0.00272	-0.000975	-0.000546	-0.00106	-0.00232	-0.00232
	(0.00922)	(0.00853)	(0.00272)	(0.00226)	(0.00120)	(0.00120)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	-0.00610	-0.00606	-0.00472	-0.00352	-0.00560	-0.00684
	(0.0113)	(0.0102)	(0.00704)	(0.00611)	(0.00555)	(0.00382)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.

TABLE XIV. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- POOLED CROSS-SECTIONAL ANALYSIS
JANUARY 2009-DECEMBER 2012 (N=4,510 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	-0.00203	0.000183	-0.00184
	(0.00705)	(0.00440)	(0.00779)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.

TABLE XV. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX (ESI) FOR EMERGENCY DEPARTMENT VISIT-POOLED CROSS-SECTIONAL ANALYSIS
JANUARY 2009-DECEMBER 2012 (N=4,505 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	-0.00491 (0.0112)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.
[d] Where 1 is most urgent and 5 is least urgent.

While no findings were significant across all models, in comparing findings from the fixed effects models to the pooled cross-sectional models, generally the fixed effects results were of greater magnitude and had less negative signs than the pooled cross-sectional findings.

In addition to the main analysis above, we performed two sub-analyses to determine if there were any significant findings when stratifying the patients by distance categories. The first sub-analysis was stratified by patients who lived closer to UI Hospital (less than the mean distance of 3 miles/12 quarter miles) and patients who lived further from UI Hospital (at least 3 miles/12 quarter miles away). This analysis can be found in Tables XLVII to LVIII, Appendix B.

The second sub-analysis stratified patients by the amount of distance change to closest FQHC from the patient's home. Patients with a distance change were stratified into two groups-those with a distance change less than the mean distance change (1.1 quarter miles), and those with a distance change of at least 1.1 quarter miles. This analysis can be found in Tables LIX to LXX, Appendix B.

G. Discussion

We found that patients who had new FQHC open closer to their home than existing FQHCs prior to ARRA were more likely to be Hispanic, were less likely to be black, and had a significantly lower poverty rate than patients who did not have a new FQHC open closer to their home during our study period. This may suggest that the new FQHCs may have opened in more Hispanic neighborhoods than black neighborhoods. Given that FQHCs are targeted for low-income neighborhoods, it is possible that FQHCs may have already existed in the lowest income neighborhoods, and the new FQHCs opened in neighborhoods that had high poverty rates, but had less poverty than neighborhoods where FQHCs already existed before the increase from ARRA.

We found no significant findings in either the patient fixed effects model (within patient) or the main pooled cross-sectional model (across patients). Our hypothesis- that having a FQHC closer to a patient's home would decrease their non-urgent ED utilization at UI Hospital- was not realized, as there was no significant association found.

While no findings were significant across all models, in comparing findings from the fixed effects models to the pooled cross-sectional models, generally the fixed effects results were of greater magnitude and had less negative signs than the pooled cross-sectional findings. With the exception of the ESI outcome, the absolute values of the coefficient magnitudes for the fixed effect models were about 10 times larger than the coefficient magnitudes for the pooled cross-sectional models. While not significant, the difference in magnitude suggest that the within patient fixed effects for change in distance may play a larger role in non-urgent ED utilization than distance to closest FQHC across patients. In terms of coefficient sign, almost all of the coefficients for the pooled cross-sectional models were negative, suggesting that as the distance to closest FQHC decreases, non-urgent ED use increases, which does not support the hypothesis. In the fixed effect models, there were negative signs on most coefficients, however there were positive coefficients for most thresholds of NE visits and the NE continuous mean probability, suggesting that for within patients, as distance to FQHC decreases, NE ED visits also decrease. But again, these relationships were not statistically significant.

Smith-Campbell (2005) looked at the change in general ED use after the opening of a new community health center, and found that after 3 years of the health center opening 1993-1995), ED visits to the local ED decreased by 40%. Our findings did not find such an association with non-urgent ED utilization. Smith-Campbell's analysis was also descriptive and it is possible that other historical events may have occurred in the 3 years of the study.

Given that we had no significant findings, there may be more involved in the patient's decision to use the ED for care versus use a FQHC. Patients may actually prefer to travel longer distances to receive hospital care over outpatient care at an FQHC. A qualitative study (Kangovi et al., 2013) of 40 urban low-SES patients explored why patients may prefer hospital care over ambulatory care. Study participants perceived hospital care to be of higher quality than ambulatory care and cited that hospitals were better able to correctly diagnose and control their medical problems. (Kangovi et al., 2013) Sarver et al. (2002) used data from the 1996 Medical Expenditure Panel Survey to look at reasons for non-urgent ED use amongst adults who had a usual source of care (USC) other than the ED (N=9,146). They found that dissatisfaction with the USC or its staff, a lack of confidence in the USC's ability were associated with having a non-urgent ED visit. (Sarver et al., 2002)

Furthermore, healthcare utilization is complex and there is more to access than location. In multiple qualitative studies, patients have cited the convenience of the ED compared to primary care. Patients reported that calling their primary care doctor to be told to go to the ED took more time than being seen in the ED. (Howard et al., 2005) The ED could be accessed via ambulance and provided a "one-stop-shop" for many services in one single location. (Kangovi et al., 2013) Additionally, after hours care at the hospital was more convenient for patients who worked regular office hours, compared to ambulatory care. (Kangovi et al., 2013; Koziol-McLain et al., 2000) As a result, the ED may actually be more convenient and/or more preferred than the ED, regardless of whether primary care capacity is increased in their neighborhood.

Additionally, this study used a primarily (75%) Medicaid study population. For Illinois Medicaid patients, in 2018, the co-pay for an emergency room visit in a non-emergency and copay for a physician/clinic visit were both $3.90. (Illinois Department of Human Services, n.d.) This means that Medicaid patients do not have a financial incentive to go to a physician's office or clinic rather than the ED, however doing so is a cost burden to the healthcare system, since a visit to the ED is more expensive than one to a clinic or doctor's office.

This study had many limitations. First, the FQHCs were not opened randomly. FQHCs are located in high-need areas (National Association of Community Health Centers, 2016), so the opening of new FQHCs likely occurred in areas with high poverty levels and high disease burden. If new FQHCs are purposefully opened in neighborhoods that would have worse health outcomes if the FQHC was not there, then we would expect the effect of a new FQHC opening to be small- as we found in our analysis.

Second, we did not know if the composition (socioeconomic, demographic, disease burden) of the neighborhoods changed over the study period. This is a limitation because it is possible that change in neighborhood composition could be the driver of change in ED visit rates (rather than distance to FQHC). This analysis assumes that our study period was short enough that there were no changes in the composition (socioeconomic, demographic, disease burden) makeup of the neighborhoods over the study time- other than the addition of the new FQHCs. Also, we only used time frame before ACA, so the resultant shift in insurance status did not affect findings. (Medicaid expansion was implemented in Cook County, IL in February 2013 and in Illinois in January 2014.)

Additionally, we treated all FQHC sites equally, regardless of quality or capacity. Treating everything the same is a limitation. Clinics may vary in quality or capacity so patients may travel further for a higher quality clinic or if there is a clinic with shorter wait times or better hours for their schedule. In addition to the new access point component of ARRA, which allowed for the opening of new FQHCs, there were other components of the Act that enhanced the care and/or capacity of existing FQHCs. Specifically, ARRA funding was allotted for increased health center staffing, extension of hours, and expansion of existing services. (Shin et al., 2010) As a result, the distance to closest FQHC may have played a less significant role than increased quality or capacity in the type of healthcare venue patients used for non-urgent needs. We did not have access to data on changes amongst already existing FQHCs so we were unable to measure this in our analysis.

We did not account for any other primary care facilities or hospital EDs that the patients in our data had convenient access to or potentially used, especially within the geography of our study area during our study time frame. We assumed that people with Medicaid or no insurance had limited choice for care and could not be seen by all PCPs, but could be seen by any FQHC. However it was possible that patients were seen at non-FQHC primary care sites. This study assumed that patients who had access to the UI Hospital ED had access to FQHCs and did not use other EDs, which is a strong assumption.

Finally, our patient level ED visit data extended past the time of the bulk FQHC openings, and through the end of 2012 so that we could look at visit patterns in our study sample over time. It was possible that during this time, there were openings or closings of other FQHCs in our study area. In looking at the 2009 to 2013 UDS reports for number of FQHCs in Chicago and Illinois that were open 30 or more hours a week, there was the greatest jump from the 2010 UDS report to the 2011 UDS report. When we received the FQHC site opening dates from HRSA, we found that the bulk of the openings were from February 2009 to July 2011. While there may have been FQHC site openings and closings during our follow-up period (July 2011 to December 2012), our study intervention period followed the bulk of the site openings. We purposefully had a short follow-up period to account for this limitation. Because of this short follow-up period, we were unable to observe long-term outcomes, which may have been welfare improving over a longer period of time.

In conclusion, our findings suggested that a decrease in distance to the closest FQHC purely induced by a new FQHC opening near patients' residences between the period February 2009 and July 2011 was not associated with a change in non-urgent ED visits within our study's geographic coverage (i.e., within 9 miles surrounding of the UI Hospital ED) and during our study period. In sub-analyses, there were some significant associations when the sample was stratified by certain distance characteristics, however these findings did not all follow the same direction for the association. This study had many limitations and as a result should be considered exploratory. Future research that uses data that includes visits to multiple EDs and visits to FQHCs and other primary care settings utilized by this patient population would provide better evidence to determine if there is truly no relationship between FQHC distance and non-urgent ED utilization, as it would give the full extent of patients' health care utilization.

Additionally, more data on specific characteristics of each FQHC, including services available (such as lab tests and imaging), operating days and hours (such as operation on the weekends), and quality indicators, could provide a better picture of patient preferences for using certain FQHC sites. Use of the ED for non-emergent issues is expensive, and further research is warranted to determine how to improve access to lower cost options such as FQHCs.

III. THE IMPACT OF THE AFFORDABLE CARE ACT ON NON-URGENT EMERGENCY DEPARTMENT UTILIZATION IN A CHICAGO, ILLINOIS HOSPITAL

A. Introduction

The Affordable Care Act (ACA) was signed into law in 2010. Reforms of the Act included expansion of Medicaid eligibility (if determined by state), insurance premiums that were subsidized, incentives to provide health care benefits for businesses, and prohibiting insurers from denying coverage for pre-existing conditions. (Elmendorf, 2010) Illinois was one such Medicaid expansion states, so in January 2014, Illinois Medicaid expansion and the Health Insurance Marketplace Exchange both took effect, increasing health insurance coverage for the uninsured.

The purpose of this analysis was to determine if the proportion of non-urgent emergency department (ED) utilization changed at University of Illinois Hospital (UI Hospital) in Chicago, Illinois after the ACA. We hypothesized that initial non-urgent ED use would increase because insurance would relieve cost barriers but the newly insured may need time to connect to the outpatient setting and may have pressing health conditions so they may initially seek care in the ED. We hypothesized that longer term non-urgent ED use would decline because once primary and specialty care was established, we believed care would be received in an outpatient setting rather than the ED.

This study is significant because patients with non-urgent ED usage may be seen more efficiently (for less cost) in other health care venues. If it is found that non-urgent ED usage has increased after ACA inception, then interventions that help patients use more efficient health care venues than the ED may be beneficial. Patients arriving to the ED with private insurance and Medicaid may have been especially affected by the introduction of the Marketplace Exchange and Medicaid expansion, so the analysis explored changes by insurance type.

Additionally, we assessed changes in non-urgent ED use based on whether or not the patient arrived to the ED during business hours. By determining which, if any, types of patients have changed the proportion of non-urgent ED usage after the introduction of the ACA, these groups can specifically be targeted for interventions.

Prior research has looked at independent state changes in insurance coverage that occurred before the ACA (Taubman et al., 2014; Miller, 2012), but research is lacking on the change in the proportion of non-urgent ED visits as a result of ACA policies. While some research is starting to emerge on this topic (Cunningham and Sheng, 2018; Garthwaite et al., 2017), whereas this study uses visit-level data, these studies have used data at the county level (Cunningham and Sheng, 2018) or have included a sample of investor-owned EDs (Garthwaite et al., 2017), which may have a different patient population than the predominately low-income patients at UI Hospital. Additionally, while this study is limited to data from only one hospital, it provides a 3 ½ year post-ACA analysis period to determine longer term trends in utilization, compared to previously published literature.

B. <u>Background</u>

At the time of the implementation of the ACA, the Congressional Budget Office (CBO) and the Joint Committee on Taxation (JCT) estimated that by 2019, the number of non-elderly Americans insured would increase by about 32 million as a result of the ACA. (Elmendorf, 2010) While the ACA included several components that changed health insurance in the US, there are two major events that took effect in Illinois, with possible implications on how Illinois patients used healthcare. First, Medicaid expansion in Illinois was authorized in July 2013 and was implemented on January 1, 2014. Illinois expanded Medicaid to adults with income up to

133% of the federal poverty level. In the first three years of expansion, there was a net increase of more than 486,000 people in the Medicaid program. (Norris, 2017)

It is important to note that Cook County, Illinois, home of UI Hospital, obtained a Section 1115 demonstration waiver to expand Medicaid for adults who live in Cook County and had income at or below 133% of the federal poverty level, which began in February 2013. However, residents who enrolled in County Care were only allowed to use services through the Cook County Health and Hospital System (CCHHS) sites, which does not include UI Hospital. (Artiga, 2014) As a result, this insurance coverage did not affect utilization at UI Hospital, and insurance coverage did not shift in patients seen at UI Hospital until the state-wide Medicaid expansion of January 2014.

Second, the Health Insurance Marketplace Exchanges opened in 2013 and coverage took effect on January 1, 2014. The Marketplace Exchange provided sliding scale subsidies for people with income less than 400% of the federal poverty level. All Americans were required to buy health insurance or else pay a fine, and insurance companies were not allowed to put restrictions on covering people with pre-existing conditions. (eHealth, 2016) As a result, implementation of the Marketplace increased the number of Americans with private insurance. (Barnett and Vornovitsky, 2016) Amongst these changes in insurance coverage in Illinois, the state's population remained relatively constant during this time, changing only -0.2% from 2010 to 2017. (United States Census Bureau, n.d.)

C. <u>Literature Review</u>

Much prior literature has explored the effects of new insurance coverage on health and healthcare utilization through both ACA events and insurance coverage changes prior to the start of the ACA. A particular interest has focused on how ED utilization has changed as a result of a gain in insurance coverage, but studies have had varying findings on how and if utilization has changed after people gain insurance coverage.

Prior to the ACA, literature has looked at change in ED utilization from programs that increased insurance coverage in Massachusetts and Oregon. In 2006, Massachusetts implemented a reform similar to the ACA, with increased insurance coverage for state residents. Change in ED utilization from this reform has varied widely across published literature. Analysis of 13.3 million ED visits in Massachusetts from 2004 to 2009 found that increased insurance coverage was associated with increased ED usage, regardless of age. (Smulowitz et al., 2014) However, two studies found a decrease in ED use from the reform. Using data from fiscal year 2004 to 2008, an individual's odds of an ED visit decreased by 4% post-enrollment. (Lee et al., 2015) A county-level analysis of the insurance expansion found that the reform reduced ED use by 5-8%. (Miller, 2012) Finally, Chen et al. (2011) found that Massachusetts' 2006 health care reform neither increased nor decreased ED use relative to utilization in other states with no reform. (Chen et al., 2011)

Then in 2008, Oregon participated in an expanded Medicaid program for uninsured, low income adults. ED use was examined in those who received coverage versus those who did not. Using data from 15 months post-expansion, those who gained coverage had a significant increase in ED usage of 40% more than the control group, including visits that would have been more appropriate in a primary care setting. (Taubman et al., 2014)

Findings on changes in ED utilization after the ACA are similarly inconsistent to reforms prior to the ACA. Some studies have found an increase in ED use. A recent study examined changes in ED visits and insurance breakdown after the ACA in Illinois. Studies have found that total ED visits increased by 5.6%-5.7% in Illinois from before ACA (2011 to 2013) to after ACA implementation (2014-2015). (Dresden et al., 2016; Sharma et al., 2016) In 2014, the first year of statewide ACA implementation, Medicaid coverage increased by 25%, private insurance coverage increased by 3%, and the uninsured population decreased by 24%. Payer-specific changes in the post-ACA period included a significant increase in average monthly visit volume (time trend) for Medicaid (41.9%) and privately insured patients (10.2%), and a significant decrease in visits for uninsured patients (42.4%). There was a positive, significant time trend change in number of overall ED visits, and specifically in those patients who were discharged home, with no significant change in ED hospitalization volume. (Dresden et al., 2016) This increased time trend change in ED visits for patients who were discharged home after the ACA suggests that these patients presented to the ED for less urgent needs than patients who were hospitalized from the ED. Such a finding suggests a need to further determine if there was an increase in non-urgent ED visits during the post-ACA period. Also, this analysis used one year of post-expansion data, so additional years of data may have different findings as patients connect to primary care.

A study that used difference-in-differences analysis on longitudinal state data from AHRQ's Fast Stats program found that ED use increased by 2.5 visits (per 1,000 people) more in Medicaid expansion states compared to non-expansion states in the post-ACA period (2014) compared to the pre-ACA period (2012 and first three quarters of 2013). (Nikpay et al., 2017) Cunningham et al. (2018) found that, for counties in California, increases in insurance coverage were associated with an increase in ED visits rates by 12.3%. (Cunningham and Sheng, 2018)

Another study found that, during the first year of state Medicaid expansion in 2014, the insurance payer mix changed, where Medicaid expansion increased ED visits by Medicaid patients by 27.1%, decreased uninsured visits by 31.4%, and decreased privately insured visits by 6.7%. However, total ED visits increased by less than 3% in 2014 compared to pre-expansion in 2012-2013, and there was no significant difference in expansion and non-expansion states. (Pines et al., 2016)

Klein et al. (2017) found that, using claims data for 48 EDs in Maryland, the total number of ED visits decreased by 1.2% from the 6 quarters before ACA to the 6 quarters after ACA. (Klein et al., 2017) Sommers et al. (2016) also found that by 2015, there was a 6% reduced likelihood for ED visits in expansion versus non-expansion states. (Sommers et al., 2016)

Some studies have looked at shifts in urgency of ED visits that have occurred with expanded insurance coverage, again with varying results. The authors of the Oregon Medicaid expansion (2008) analysis also looked at change in visit urgency using the NYU Algorithm by Billings et al. (Billings et al., 2000b). (The NYU Algorithm was used to define non-urgent outcomes for our analysis and more details can be found in the "Dependent Variables" section of this paper.) They found that the greatest increases after receiving coverage were for visits that were primary care treatable and non-emergent. (Taubman et al., 2014)

One study used data from 126 ED visits to for-profit, investor-owned hospitals to compare types of visits in Medicaid expansion states and non-Medicaid expansion states. Using the NYU Algorithm (Billings et al., 2000b), the authors found that after Medicaid expansion, visits for non-emergent conditions decreased by 43.9% for uninsured patients and increased by 129.7% among Medicaid patients. Additionally, Medicaid visits increased by 146.9% for primary care treatable visits in expansion states. The authors also found a substantial increase in visits where ED care was needed (161.6% for preventable and 123.9% for not preventable). (Garthwaite et al, 2017) The increase for Medicaid patients in all categories of visit urgency suggest that the findings may be a result of the increase in Medicaid patients using the ED in general, and do not speak to a possible shift in ED usage towards or away from non-urgent needs. Additionally, this study did not include non-profit or public hospitals, which may have a different patient population than for-profit hospitals.

At the county level, in California from 2012 to 2015, rates of preventable ED visits increased by 10.9%. Counties with higher levels of ED use had fewer primary care providers. (Cunningham and Sheng, 2018) Using data from the Massachusetts insurance reform of 2006, the reform reduced ED visits by 5-8%, nearly all of which was for non-urgent visits, with greatest reduction during regular business hours, when doctor's offices are open. There was no change in non-preventable ED visits. (Miller, 2012) Sharma et al. (2016) looked at Ambulatory Care Sensitive Hospitalizations, which can be used as a measure of access to timely outpatient care. They found that the proportion of uninsured ED hospitalizations classified as ACSH remained stable before (2011-2013) and after (2014-2015) ACA. (Sharma et al., 2016)

Studies have also looked at the mechanisms for changes in utilization after receiving insurance coverage. Using pre-ACA national survey data, one study found that the uninsured use the ED substantially less than people on Medicaid (average number of ED visits per capita for uninsured=0.177, and for Medicaid=0.523). The uninsured also use other types of care much less than the insured (average number of outpatient visits per capita- uninsured= 2.14 vs Medicaid= 8.73). (Zhou et al., 2017)

Many studies have shown that increased insurance coverage is associated with increased preventive and primary care utilization. In comparing those without expanded coverage to those with expanded insurance coverage, studies have shown that a gain of insurance coverage has increased primary care physician visits, increased having a usual source of care, and improved access to primary care. (Gray et al., 2016) Insurance coverage has also increased the use of preventive care, such as having annual check-ups, and having outpatient visits. (Gray et al., 2016) Coverage has been associated with decreased skipped medication usage due to cost (Sommers et al., 2015; Sommers et al., 2016) and decreased out-of-pocket spending. (Sommers et al., 2015; Sommers et al., 2016; Sommers et al., 2017) It has also been associated with increased self-reported health. (Sommers et al., 2015; Simon, 2016; Sommers et al., 2017)

A qualitative study (Artiga et al., 2015) on people who were once uninsured and then received insurance through Medicaid expansion can further explain these relationships. Findings showed that while uninsured, patients tend to delay or go without needed care because of the cost, which can lead to worsening of conditions. In terms of ED utilization, the participants tried to avoid the ED in order to minimize costs, and would only go if their condition became severe. After the participants received coverage, they went to primary care providers (PCPs) and specialists for care rather than waiting for their condition to become urgent and go to the ED for care, although some participants reported difficulty finding a PCP and some types of specialists. Obtaining coverage allowed this group to access care to address current problems and receive primary and preventive care. Obtaining coverage also allowed for better management of chronic conditions, diagnosis of conditions, and health improvements. Likewise, once people gained coverage, they could obtain needed prescription drugs, rather than go without them, take less than prescribed, or use expired or family members' medication due to costs. (Artiga et al., 2015)

Prior literature has also differed on whether there is evidence that being uninsured creates a pent-up demand for care. One study (Fertig et al., 2016) that looked at new Medicaid enrollees compared to ongoing enrollees in Minnesota found that the probability of an office visit and an ED visit declined over the first 6 months of coverage. These findings suggest that the newly insured connect to primary care and have a declining reliance on the ED over time. (Fertig et al.,

2016) Another study also found that cost and utilization increases among new Medicaid enrollees in California was temporary. (Lo et al., 2014) One year after Medicaid expansion in California, there was a significant decline in use of hospital inpatient care and the ED, with a stable rate of use of outpatient service. This finding suggests that newly eligible Medicaid beneficiaries have a pent-up demand for care, and the demand declines rapidly after the first year of enrollment. (Lo et al., 2014)

In a follow-up analysis of the Oregon Medicaid expansion program in 2008, the increase in ED use continued to persist at a constant level after the first two years over coverage, suggesting no pent-up demand. The authors suggested that this evidence shows that Medicaid coverage makes the physician's office and use of the ED complementary, and not substitutable. (Finkelstein et al., 2016) However, the authors only looked at ED visits in general for this follow-up analysis, and not type of ED visits (non-urgent versus not).

Studies have shown that it may take some time for newly insured to connect to primary or outpatient care. A study of the Massachusetts insurance reform of 2006 found that the odds of ED visit varied by pre-enrollment insurance status, where odds of an ED visit were 12% higher post-period for enrollees who were not publicly insured prior to expansion, but was 18% lower for enrollees who transitioned from a program that pays for limited services for low-income individuals called the Health Safety Net. (Lee et al., 2015) This finding suggests that those who previously had no coverage may have needed time to connect to primary care in an outpatient setting and used the ED for their immediate needs, compared to patients who were already connected to limited services, who may have already been connected to health services.

Among people in Medicaid expansion states who reported access problems, 35% were told that a doctor was not taking new patients, 30% could not find a doctor willing to see them, and 67% delayed care because they could not get an appointment. (Shartzer et al., 2016) Furthermore, another study found an increased rate of difficulty obtaining specialist appointments in 2016 in the expansion states.(Sommers et al., 2017) Compared to non-expansion states, survey data has shown that people in expansion states post-ACA had an increase in reports that medical care was delayed because of wait times for appointments. (Miller and Wherry, 2017) These findings suggest that an increase in patients with insurance coverage through ACA may have led to difficulty obtaining immediate outpatient care when insurance coverage was first established.

D. Conceptual Model

Based on a synthesis of the literature, our hypothesis is modelled in Figure 6. The uninsured may have avoided the ED and other health care due to cost, resulting in worsening of health conditions. The uninsured may have needed to go to the ED due to an urgent need from worsening of conditions (as a last resort). When the uninsured gained coverage, they may have had existing health conditions that needed care and no longer had a cost barrier to care. They may have initially gone to the ED while establishing outpatient care (PCPs and specialists), as outpatient care may have had increased wait times to accommodate the increase in new patients with health insurance. Despite this potential wait, we expected that patients would eventually shift their non-urgent care needs to an outpatient setting rather than the ED. Therefore, we expected that the immediate (level) change in proportion of non-urgent ED visits at UI Hospital would increase but that over time non-urgent ED visits at UI Hospital would decrease (negative time trend).

Figure 6. Conceptual Model of Hypothesized Findings for the Impact of the Affordable Care Act on Non-Urgent Emergency Department Utilization at University of Illinois Hospital

Uninsured tend to avoid the ED because of costs

Initial non-urgent ED use will increase (positive level change)- Insurance relieves cost barrier but newly insured need time to connect to the outpatient setting and may have pressing/worsening conditions as a result of avoiding care so will initially seek care in the ED

Longer term change for non-urgent ED use will decrease (negative time trend change)- Once primary and specialty care are established, non-urgent care will be received in an outpatient setting rather than the ED

E. <u>Methods</u>

1. <u>Study Setting</u>

This study used patient data from the UI Hospital ED. The UI Hospital ED is a 24-hour facility that serves a diverse Chicago population. It is located within the Illinois Medical District- a predominately African-American and Latino neighborhood with a high density of publicly insured residents. UI Hospital's patients mostly reside on the west, south, and southwest sides of Chicago. The hospital's primary service area encompasses 5 of the 10 poorest neighborhoods in the City of Chicago. Adult patients represent about 75% of all ER visits.

During the timeframe of interest (January 2012- May 2017), the volume of inpatient and outpatient visits at UI Hospital by month can be seen below in Figures 7 and 8. Inpatient visits fluctuated by month but overall stayed relatively constant with 1684 visits in January 2012 to 1653 visits in May 2017. The number of outpatient visits increased by 30.8% over the same period, from 36,453 in January 2012 to 47,665 in May 2017.

Figure 7. Number of Inpatient Visits at University of Illinois Hospital by Month (January 2012-May 2017)

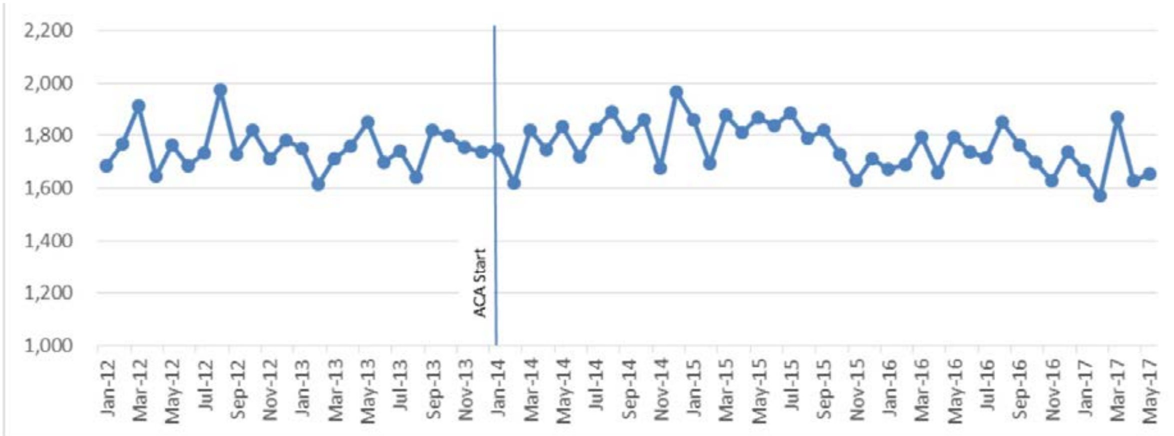
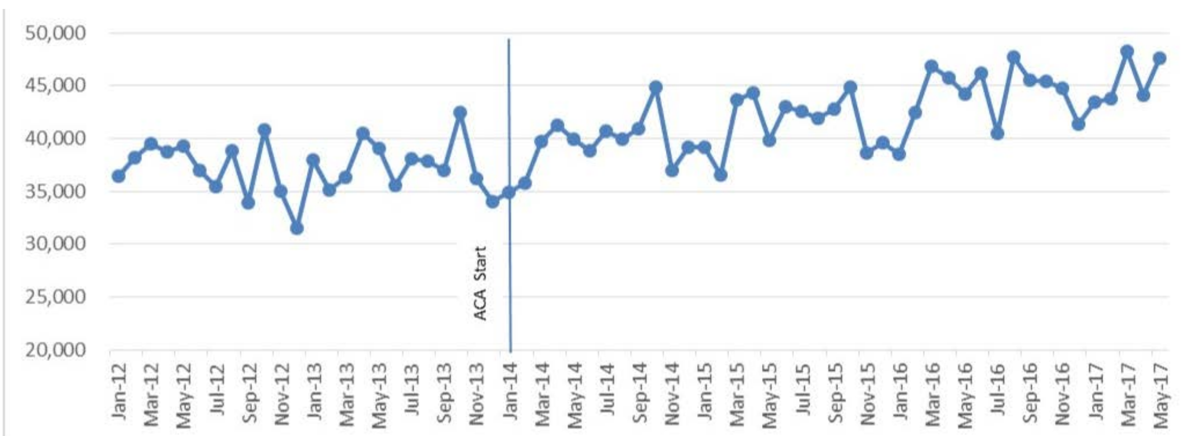


Figure 8. Number of Outpatient Visits at University of Illinois Hospital by Month (January 2012-May 2017)



2. <u>Sample</u>

We looked at ED visits by week from January 2012 to May 2017 in UI Hospital in Chicago, IL. Visits were excluded from the study if the patients were under 19 years of age (N= 58,366) or older than 64 years (N=27,650), or did not have an Illinois address listed in their patient chart (N= 5,327). We excluded children 18 years and younger because low-income children were eligible for the Illinois Comprehensive Health Insurance Plan (CHIP) (Illinois Comprehensive Health Insurance Plan, 2015), and excluded adults over 64 years old because they were eligible for Medicare insurance. Both CHIP and Medicare were not affected by the ACA. We excluded patients who did not live in Illinois because they were not eligible for expanded Illinois Medicaid insurance. We also excluded visits where the patient did not have a discharge diagnosis listed in either the EMR or billing data (N=9,357). In most instances, this occurred when a patient presented to the ED but was immediately transferred to the emergency unit of the obstetric service of the hospital. The total number of eligible visits for the study was 156,044.

Study data came from two sources. First, data were pulled through a batch report directly from Cerner (Cerner Corporation, Kansas City, MO) electronic medical records (EMR). The EMR data included all demographic variables of interest (race, ethnicity, age, gender, insurance type, arrival date and time to ED, and home address). Second, billing data from Wolcott, Wood, and Taylor, Inc. (WWT) were used. The billing data were matched to EMR data because billing data have more complete and accurate International Classification of Diseases, Ninth Revision (ICD-9) and Tenth Revision (ICD-10) data. The process for determining a diagnosis code is that the physicians document in the chart the patient signs and symptoms along with the patient diagnosis. Then professional coders provide the coding of the ICD code of the diagnosis and then the encounter is sent to the billing company (WWT) for submission to the payer. Therefore, the ICD codes in the billing data were prioritized over those in the EMR data. The ICD codes were only used from the EMR data if the code was missing from the billing data. The hospital fully switched from using ICD-9 coding to ICD-10 coding on October 15, 2015, so ICD-9 codes were used for 2009-2014 data, and ICD-10 codes were used for 2016 and 2017 data. Both ICD-9 and 10 codes were used for 2015 data.

It was possible for a visit to have more than one discharge diagnosis code and we used the primary diagnosis code. The ICD codes were listed in the order from the most significant reason for the visit to the least significant reason for the visit, so by using the primary diagnosis code, this was the main reason for the visit.

Each patient had a unique medical record number (MRN) as well as a date of service in both the billing and EMR data. In order to match patients' demographic characteristics to the appropriate visit, we merged visit records from the EMR to billing records using a merging key of MRN+date of service. It was possible for a patient to have more than one MRN listed in the EMR. This could be caused by a patient that is unconscious at time of arrival to the ED and is registered as a John or Jane Doe; a patient that uses multiple aliases; or a registration error, where the clerk fails to locate the patient's record. As a result, the MRN+date merging key resulted in some visits for these patients having no match with the billing data. Therefore a merging key was constructed of the patient's last name+first name+date of service. We used the primary, original insurance type from the billing data. If insurance type was missing in the billing data, we used insurance type from the EMR data.

We created a discrete, unique variable for each week of the study period (1-282). After the dataset was created, all visits were collapsed at the week level with the mean proportion or prevalence of all outcomes and covariates for ED visits for each week. For example, if half of the patients who came to the ED in week 1 were Hispanic, then the Hispanic variable for Week 1 was 0.5. For continuous covariates, such as zip code level poverty rate, the values for all visits for the week were averaged together to give a value for the week. Similarly, for continuous outcomes (see more details in the Dependent Variables section), the values for all visits in the week was averaged together to give a value for the week. For outcomes that were binary at the visit level (e.g., visit was above the threshold of 50% non-emergent (yes or no)), we created a proportion of the number of visits with the outcome of interest divided by the total number of all ED visits for the week. For example, if in Week 1 there were 100 visits above the threshold of 50% non-emergent and 200 ED visits total, then the 50% non-emergent proportion for that week was 0.5. Since data was collapsed at the visit level, and not the patient level, if patients presented to the ED multiple times in a week, they were included multiple times within the collapsed proportions of the week.

Collapsed datasets were also created for three stratified analyses of interest (only Medicaid patients, only private insurance patients, and only patients who came to the ED during business hours). All data cleaning and analysis was completed using Stata Version SE 14.2 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

3. Timeframe

We were interested in the change in proportion of non-urgent ED visits from the implementation of the ACA events of Medicaid expansion in Illinois and the Marketplace Exchange. Both events were implemented January 1, 2014. Our pre-intervention period was January 2012 to December 2013 and our post-intervention period was January 2014 to May 2017.

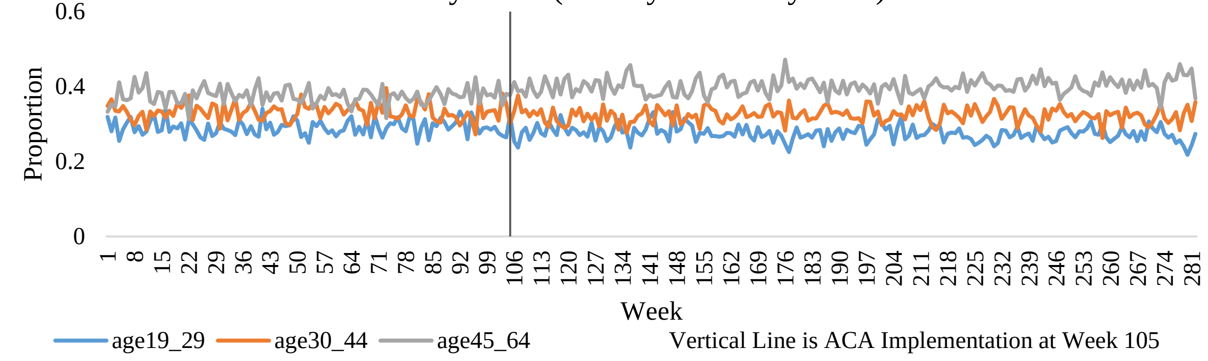
4. Covariates

There are many patient characteristics that have been associated with non-urgent ED utilization. The some factors- Social Support, Health Status, Personality, Previous Healthcare Experience, and Culture and Community Norms (Uscher-Pines et al., 2013)- were unobservable factors that we were unable to control for in our models. Other factors- Age, Gender, Race, Insurance type, and Socioeconomic Status, (Uscher-Pines et al., 2013) were observable factors that were controlled for in our models. It is important to control for the observable variables that we had available in the data because of their potential impact on the study outcomes in order to avoid omitted variable bias.

a. <u>Age</u>

In 2015, 25-44 year olds made up the highest percentage of ED visits (28.6%), followed by 45-64 year olds (21.3%), people under 15 years (19.8%), people 65 years and older (15.6%), and then 15-24 year olds (14.7 %). People 25-44 years old also had the highest number of visits per 100 persons per year with 47.3 visits, followed by 15-24 years (47.0), 65+ years (46.0), under 15 years (44.5), and 45-64 years (35.0). (Rui and Kang, 2017) According to the 2015 NAMCS, people 65 years and older had the highest proportion of office visits compared to the other age groups at 30.9%. Their visit rate (number of visits per 100 persons per year) of 657.8 was more than twice the average for all age groups (313.3). For 45 to 64 year olds, the rate was also above the average, at 366.3 visits, and represents 30.8% of all office visits. All other age groups had a lower than the average rate. (Rui and Okeyode, 2017) Overall, elderly patients have more medical needs than younger people, so they have higher rates of medical use. For this analysis, we used age groupings based on the Centers for Disease Control and Prevention's reporting of emergency room patient demographics from the National Health Interview Survey in a National Health Statistics Report (Gindi et al., 2016), with the exception of changing the 18-29 year age group to 19-29 years. Figure 9 shows the age breakdown of UI Hospital ED visits for 19 to 64 year old adult patients who lived in Illinois by week over the study period.

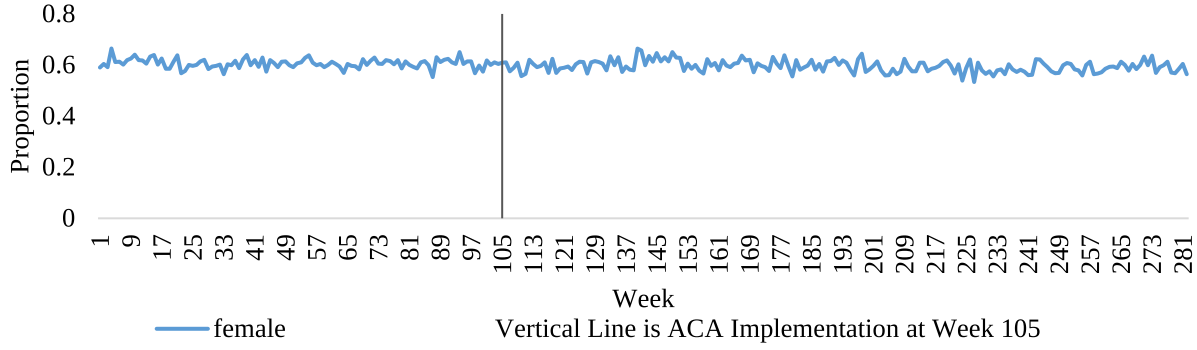
Figure 9. Proportion of Emergency Department Visits by Age Group at University of Illinois Hospital for Adults (19 to 64 years) who Reside in Illinois by Week (January 2012-May 2017)



b. **<u>Gender</u>**

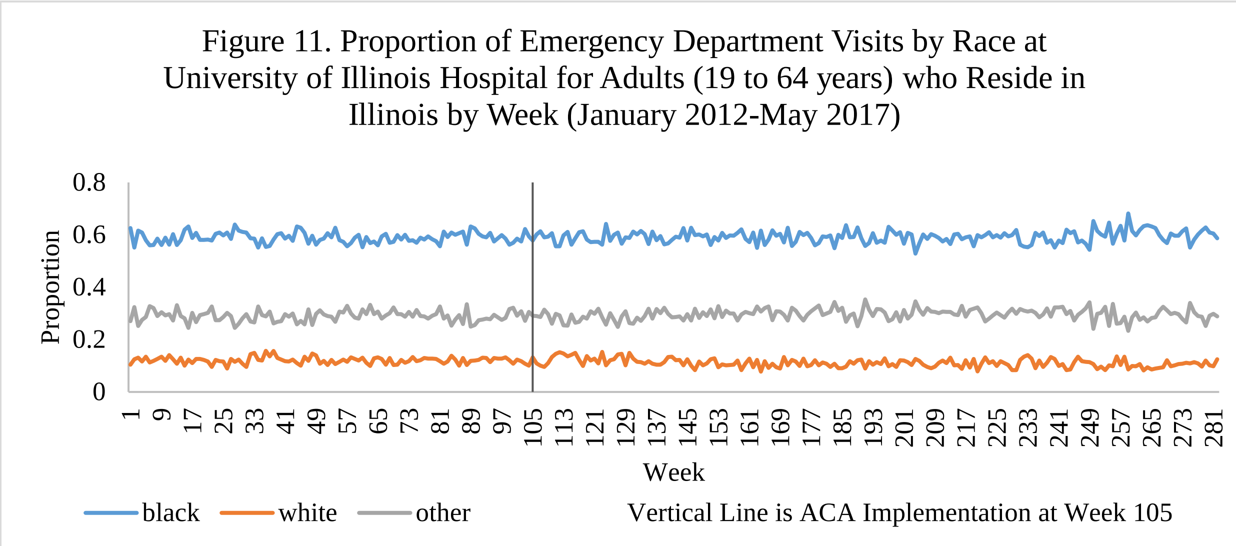
Compared to males, females are significantly more likely to have 5+ ED visits annually for non-emergent needs. (Behr and Diaz, 2016) The 2015 NHAMCS found that the number of ED visits per 100 persons per year was 46.9 for women, compared to 39.5 for men. (Rui and Kang, 2017) Females also had more physician office visits than men, with 59.1% of visits, and 362.2 visits per 100 persons per year compared to 262.1 for men. (Rui and Okeyode, 2017) The higher overall utilization of healthcare (ED and physician office) by females suggests that this is an important variable to take into consideration for this study. Figure 10 shows the proportion of females for UI Hospital ED visits for 19 to 64 year old adult patients who lived in Illinois by week over the study period.

Figure 10. Proportion of Female Emergency Department Visits at University of Illinois Hospital for Adults (19 to 64 years) who Reside in Illinois by Week (January 2012-May 2017)



c. **<u>Race</u>**

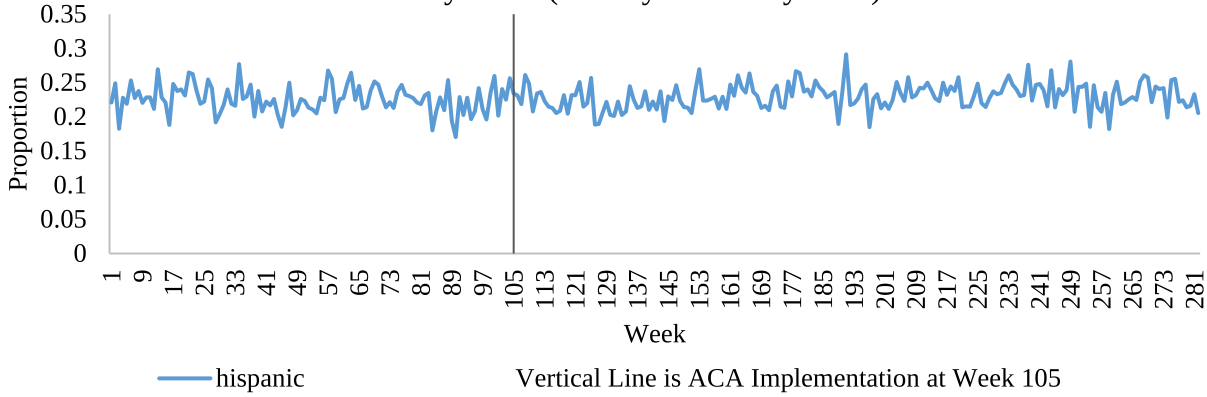
Black patients are significantly more likely to have 3+ ED visits for non-emergent needs compared to other races.(Behr and Diaz, 2016) According to the 2015 National Hospital Ambulatory Medical Care Survey (NHAMCS), white patients made up a higher percentage of ED visits (73.3%) than black patients (23.3%) or other (3.4%). However the number of visits per 100 persons per year was higher for black patients (77.3) than white patients (41.1). (Rui and Kang, 2017) Figure 11 shows the breakdown by race for UI Hospital ED visits for 19 to 64 year old adult patients who lived in Illinois by week over the study period.



d. **Ethnicity**

Differences in ED and outpatient visits differ by ethnicity, where Hispanic patients have lower rates of ED and outpatient visits than non-Hispanic patients. According to the 2015 NHAMCS, Hispanic patients made up 16.5% of all ED visits in the US, with a rate of 40.4 visits per 100 persons per year, compared to non-Hispanic patients with 83.5% of visits and 43.9 visits per 100 persons per year. (Rui and Kang, 2017) According to the 2015 National Ambulatory Medical Care Survey (NAMCS), Hispanic patients made up 14.1% of all physician office visits, with a rate of 250.0 visits per 100 persons per year, compared to non-Hispanic patients with 85.9% of visits and 326.9 visits per 100 persons per year. (Rui and Okeyode, 2017) Figure 12 shows the proportion of UI Hospital ED visits for Hispanic 19 to 64 year old adult patients who lived in Illinois by week over the study period.

Figure 12. Proportion of Hispanic Emergency Department Visits at University of Illinois Hospital for Adults (19 to 64 years) who Reside in Illinois by Week (January 2012-May 2017)



e. **<u>Insurance Type</u>**

Overall, our analysis examined the change in proportion of non-urgent ED visits when patients gained insurance coverage, so the insurance change was our independent variable that changed at the time of the ACA implementation. We also controlled for insurance type in our models that look at all ED patients and those who arrived during business hours. We then stratified analysis by type of insurance, specifically for Medicaid patients and private insurance, as these are the types of insurances that patients who gained coverage from ACA are covered under (where Medicaid Expansion moved patients from uninsured to having Medicaid coverage and the Marketplace Exchange allowed people to move from uninsured to private insurance).

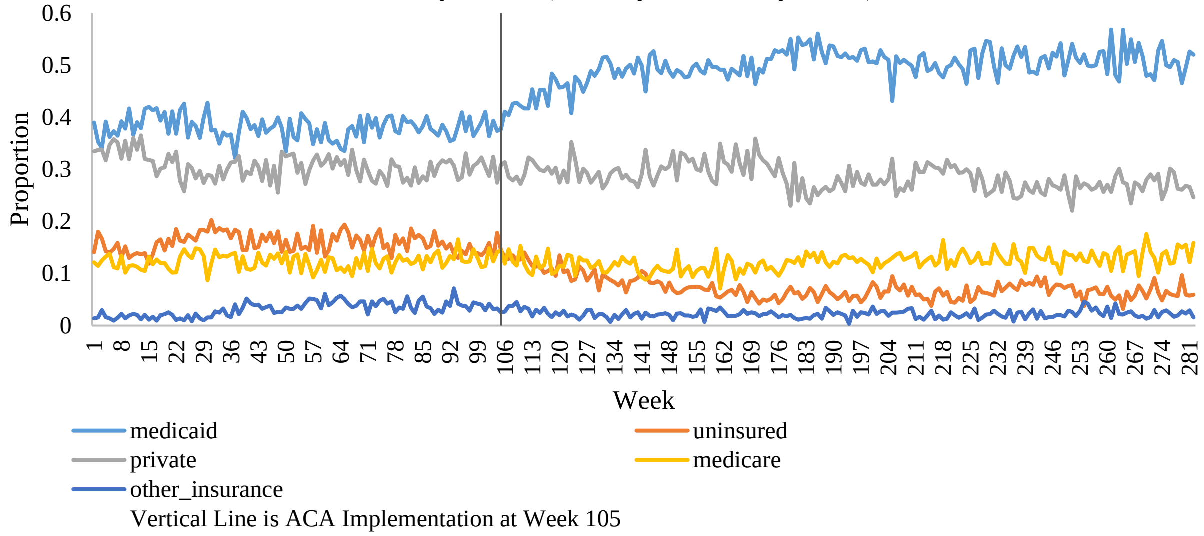
Literature has found that healthcare utilization can vary based on insurance type. The 2013 NHAMCS estimated that ED patients had private insurance in 36.0% of visits, Medicaid or CHIP in 30.0% of visits, Medicare in 19.6% of visits, and no insurance for 15.1% of visits. (Rui et al., 2016) After expansion of ACA, the 2015 NHAMCS estimated that the payer composition for ED patients was 34.3% private insurance, 34.8% Medicaid or CHIP, 17.7% Medicare, 3.6% Medicare and Medicaid, and 9.8% no insurance. (Rui and Kang, 2017) One study found that patients with Medicare or Medicaid were 2.6 times more likely to have 5+ ED visits in a year for non-emergent needs compared to other insurance types. (Behr and Diaz, 2016)

Over half of physician office visits in 2015 were by patients with private insurance (55.8%), followed by Medicare patients (27.2%), Medicaid patients (15.8%), patients with no insurance (5.2%), and patients with Medicaid and Medicare (2.0%). (Rui and Okeyode, 2017)

These differences in utilization may be related to differences in access across insurance types. Adults with Medicaid were most likely to report that their ED visit was due to the seriousness of their problem and those with private insurance were most likely to have used the ED because their doctor's office was not open. (Gindi et al, 2016) Uninsured adults were significantly more likely than adults with private insurance or Medicaid to have visited the ED because of a lack of access to other providers. (Gindi et al., 2016) However, adults with Medicaid and Medicaid + Medicare whose last ED visit did not result in a hospitalization were more likely to seek care in the ED because of barriers to accessing outpatient services than those with private insurance. (Capp et al., 2014)) A qualitative study of 40 urban low-socioeconomic patients found that uninsured patients could not afford ambulatory visit fees and relied on hospital charity care. (Kangovi et al., 2013)

Figure 13 shows the breakdown by insurance type for UI Hospital ED visits for 19 to 64 year old adult patients who lived in Illinois by week over the study period. "Other" insurance includes payers that did not fit into any other category- such as worker's compensation and patients coming from correctional systems.

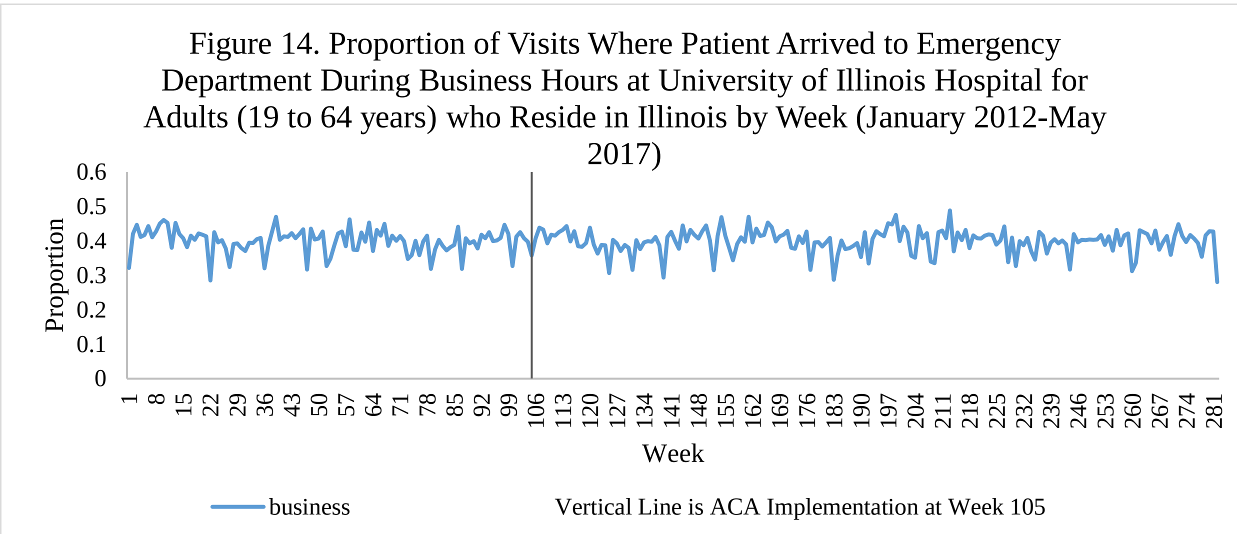
Figure 13. Proportion of Emergency Department Visits by Insurance Type at University of Illinois Hospital for Adults (19 to 64 years) who Reside in Illinois by Week (January 2012-May 2017)



f. <u>Arrival to ED During Business Hours</u>

We explored the timing of the arrival of the patient to the ED, in order to take into account availability of alternatives to the ED when the patient came to the ED. While the ED is always open, other care facilities (such as urgent care centers and physician offices) are typically open during business hours. This was categorized as either a business hour visit (Monday through Friday, 8am-5pm) or non-business hour visit (all other hours). For business hour visit we used Monday through Friday, 8am to 5pm, as this is consistent with published literature (Capp et al., 2015; Pitts et al., 2012). Nationally, from 2001 to 2008, there was a 7.5% increase in ED visits arrivals during traditional office hours (Monday through Friday, 8am-5pm), when clinics are open. Also, during this time, ED visits by patients with private insurance decreased by 0.3%, visits by Medicare patients and Medicaid patients increased by 6.9 and 6.7%, respectively, and visits by uninsured patients increased by 2.5%. (Pitts et al., 2012) Forty-five percent of

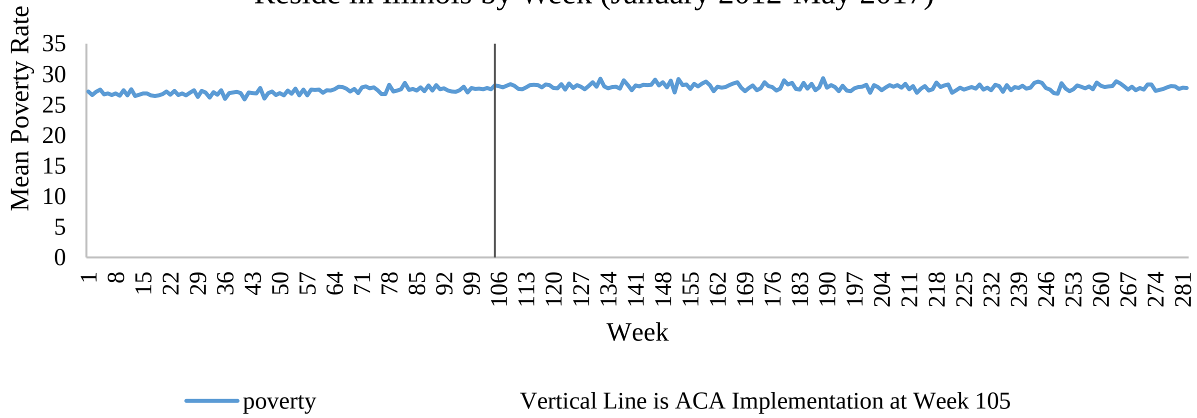
Medicaid patient visits to the ED occurred during business hours (8am to 5pm, Monday-Friday). (Capp et al., 2015) Figure 14 shows the proportion of UI Hospital ED visits who arrived at the ED during business hours during the study period.



g. <u>Zip Code Level Poverty Rate</u>

We collected patient zip codes from the EMR and determined zip code-level poverty rate based on poverty metrics from the American Community Survey (ACS) (U.S. Census Bureau). The poverty rate was the number of people in each zip code below the poverty level divided by the total number of people living in the zip code. For 2012 visits we used data from the 2008-2012 5-year ACS data, for 2013 visits we used the 2009-20135-year ACS data, for 2014 visits we used the 2010-2014 5-year ACS data, and for 2015-2017 visits we used the 2011-2015 5-year ACS data. Figure 15 shows the breakdown by poverty level for UI Hospital ED visits for 19 to 64 year old adult patients who lived in Illinois by week over the study period.

Figure 15. Mean Poverty Rate (by Zip Code) for Emergency Department Visits at University of Illinois Hospital for Adults (19 to 64 Years) who Reside in Illinois by Week (January 2012-May 2017)



h. Month

To account for seasonality, a dummy variable for each month (January-December) was included in each model. For the interrupted time series models that were collapsed to the week level, the month that corresponded with each week was the one that started the week. For example if week 5 included both January and February dates, it was included as January for month.

i. Overall Patient Composition

Based on Figures 9 through 15, the demographic composition was relatively constant across the study period, with the exception of insurance type in Figure 13. Figure 13 shows trends in insurance type during the study period, where there were higher proportions of Medicaid patients and lower proportions of uninsured and private insurance patients after the ACA, compared to the pre-ACA period.

TABLE XVI quantifies the visits pre- and post-ACA, and shows the UI Hospital ED patient composition for each study period, with significance testing for before ACA versus after ACA. Proportion of females, insurance type, age group, and zip code level poverty rate were significantly different between the two periods. There was a small but significant decrease in the proportion of females post-ACA. There was an increased proportion of visits by patients with Medicaid, and a decrease in patients with no insurance and private insurance. There was no significant change in the proportion of visits for Medicare patients. It is interesting to note that the proportion of patients with private insurance decreased, considering that the Marketplace Exchange was enacted during this time. Since these values are proportions of all ED visits, the proportion of visits by patients with private insurance likely decreased due to the increase in the proportion of patients with Medicaid. Furthermore, the proportion of visits made by 19-29 year olds significantly decreased from the pre-period to the post-period, and the proportion of visits made by 45-64 year olds significantly increased during this time. The mean zip code level poverty rate also significantly increased from the pre-period to the post-period.

5. Independent Variable of Interest

The independent variable of interest in this study represents the introduction of the ACA in January 2014- reflecting the timing of both the introduction of Illinois Medicaid expansion and the introduction of the Marketplace Exchange.

6. Dependent Variables

The outcome was the proportion of non-urgent ED utilization- measured using the NYU Algorithm and the Emergency Severity Index (ESI).

TABLE XVI. UNIVERSITY OF ILLINOIS HOSPITAL EMERGENCY DEPARTMENT PATIENT COMPOSITION, 19-64 YEAR OLDS (%)-BEFORE AND AFTER IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)

Variable	Pre-ACA Period (Weeks 1-104) N=54,410 visits	Post-ACA Period (Weeks 105-282) N= 101,634 visits	p-value[a]
Black	58.9	59.3	0.498
White	12.1	11.1	0.056
Other	29.0	29.7	0.218
Hispanic	22.6	23.0	0.424
Female	60.6	59.6	**0.042**
Medicaid	38.0	49.8	**0.000**
Uninsured	15.9	7.2	**0.000**
Medicare	12.3	12.3	0.956
Private Insurance	30.6	28.4	**0.000**
Other	3.2	2.2	0.069
19-29 years	29.1	27.5	**0.003**
30-44 years	33.3	32.4	0.061
45-64 years	37.6	40.1	**0.000**
Arrived to ED During Business Hours	40.0	39.9	0.845
Poverty Rate of Patient's Zip Code	27.2	28.0	**0.000**

[a]Z-test of proportion was used for all variables, except t-test was used for the continuous variable of poverty rate.

a. NYU Algorithm

The NYU Algorithm is a validated measure (Ballard et al., 2010) that has been used by much published literature to characterize the urgency of ED visits (Billings and Raven, 2013; McCormack et al., 2016). The algorithm was developed by a group of emergency medicine and primary care physicians to categorize ED visits into four categories based on level of urgency. Using a sample of complete ED records from 1994 and 1999, the creators reviewed 5,700 patient medical records from six Bronx, New York hospitals to determine an algorithm that uses patient discharge ICD-9 and ICD-10 codes to categorize each visit. (Billings et al., 2000b)

The reviewers used patient information on initial complaints, ED procedures performed, ED resources used, vital signs, age, medical history, and discharge diagnosis. In the first step of the algorithm, patients were categorized as Emergent if they needed contact with the medical system within 12 hours or Non-Emergent if not. This was determined based on initial complaint, age, gender, temperature, respiratory rate, pulse rate, symptom duration, and comorbidities. (Billings et al., 2000b)

In the second step of the algorithm, the Emergent cases were then categorized as Primary Care Treatable if care could have been provided in a non-ED setting, or ED Care Needed otherwise. This was based on the procedures and resources used in the ED. Patients were categorized as Emergent- ED Care Needed if they used resources not typically available in a non-ED setting (e.g., CAT scan). Patients were categorized as Emergent- Primary Care Treatable if they did not use resources in the ED or used those generally available in a non-ED setting (e.g. routine blood test). If the initial complaint alone justified ED use (e.g. chest pain or gastrointestinal obstruction), then the patient was categorized as Emergent- ED Care Needed, regardless of resources used. (Billings et al., 2000b)

In the third step of creating the algorithm, the chief complaints were paired with the eventual discharge diagnosis to define the percent of diagnoses that belonged in the step 1 and step 2 categories. For example, a patient with a diagnosis of abdominal pain who only used resources in the ED that are available in a non-ED setting could be classified as Emergent- Primary Care Treatable. However, a patient could be classified as Emergent- ED Care Needed if he came to the ED with a chief complaint of chest pain, was treated for a possible heart attack, and had a discharge diagnosis of abdominal pain. The percentages of discharge diagnoses that fell into each category composed the probabilistic percentage for each diagnosis code. (Billings et al., 2000b)

Finally, in the fourth step of creating the algorithm, Emergent- ED Care Needed cases were classified as either Preventable/Avoidable or Not Preventable/Avoidable. A case was considered to be preventable if episodes of the condition could have been more effectively managed with timely and effective outpatient care. This determination was based on the ambulatory care sensitive condition classification scheme that was previously developed by the authors for use in analysis of hospital discharges. (Billings et al., 2000b)

In summary, the algorithm breaks visits into four categories based on discharge diagnosis code (ICD-9 and ICD-10) (Billings et al., 2000b):

1. Non-Emergent (NE)– "The patient's initial complaint, vitals signs, medical history, and age indicated that immediate medical care was not required within 12 hours."; (Billings et al., 2000a)
2. Emergent/Primary Care Treatable (PCT)- "Treatment was required within 12 hours, but care could have been provided in a primary care setting. The complaint did not require continuous observation, and no procedures were performed or resources used that are not available in a primary care setting (e.g., CAT scan or certain lab tests)."; (Billings et al., 2000a)
3. Emergent - ED Care Needed - Preventable/Avoidable (EDP) – "Emergency care was required based on the complaint or procedures or resources used, but the emergent nature of the condition was potentially preventable or avoidable if timely and effective primary care had been provided (e.g., flare-ups of asthma, diabetes, or congestive heart disease)."; (Billings et al., 2000a)
4. Emergent - ED Care Needed - Not Preventable/Avoidable (EDNP) – "Emergency care was required and primary care treatment could not have prevented the condition

(e.g., trauma, appendicitis, or heart attack).” (Billings et al., 2000a)

Additionally, diagnoses can be categorized as mental health related, alcohol related, substance abuse related, injury, or unclassified if they do not fall into any categories (e.g., fitting/adjusting of medical equipment, cholera, or suicidal ideation). (Billings et al., 2000b) Our outcomes focused on the categories of Non-Emergent (NE) and Primary Care Treatable (PCT) because these were the categories where the algorithm suggests that ED care is not needed.

Diagnostic categories are generally not clear-cut in all cases. Therefore, the algorithm reflects potential uncertainty and variation by assigning cases on a percentage basis. Examples of the categorization of some common diagnoses using the algorithm are found in Table XVII.

TABLE XVII. EXAMPLES OF NYU ALGORITHM PROBABILITIES FOR A SAMPLE OF DIAGNOSES

Diagnosis	**ICD-10[a] Code**	**% ED Care Needed, Not Preventable**	**% ED Care Needed, Preventable /Avoidable**	**% Emergent, Primary Care Treatable (PCT)**	**% Non-Emergent (NE)**
Unspecified abdominal pain	R10.9	33%	0%	67%	0%
Shortness of breath	R06.02	60%	0%	40%	0%
Chest pain, unspecified	R07.9	68%	0%	32%	0%
Streptococcal pharyngitis (Strep throat)	J02.0	0%	6%	28%	66%
Cough	R05	12%	0%	24%	65%
Dorsalgia, unspecified (Back pain)	M54.9	11%	0%	15%	74%
Nausea	R11.0	18%	0%	24%	59%
Otitis media, unspecified, unspecified ear (Ear infection)	H66.90	0%	4%	59%	37%
Headache	R51	13%	0%	9%	78%
Plantar wart	B07.0	0%	0%	0%	100%
Carpal tunnel syndrome, unspecified upper limb	G56.00	0%	0%	0%	100%
Ocular pain, unspecified eye	H57.10	0%	0%	100%	0%
Heartburn	R12	0%	0%	100%	0%

[a]ICD-10= International Classification of Diseases, 10th Revision

For this analysis, we used the outcome variables shown in Table XVIII, which were all continuous outcomes. NE50-NE95, PCT50-PCT95, and NEPCT50-NEPCT95 were the proportion of visits, out of all ED visits for the week, with an ICD code with a probability that the diagnosis was at or above the non-urgent threshold. For example, for NE50, this was the proportion of ED visits for the week where the non-emergent probability given by the NYU Algorithm was greater than or equal to 50%, out of all ED visits for the week.

A 2013 systematic review of 26 articles on visiting the ED for non-urgent conditions found that no two articles had the same definition of non-urgent visits. (Uscher-Pines et al., 2013) Even other studies that have used the NYU Algorithm have used it differently. For example, the previously referenced Taubman et al. (2014) used continuous means for each category for their analysis. Other studies have created a non-emergent variable by summing the probabilities of NE and PCT to make a dichotomous variable of 1 if the probability was greater than 50% and 0 if it was less than or equal to 50%. (Gandhi et al., 2014) Our models included both of these outcomes, as well as others. To account for the many ways to determine if a visit was non-urgent, we created multiple thresholds for each non-urgent category (NE, PCT, and NEPCT) at 50-95% probability that the diagnosis was within the category. This allowed us to explore the sensitivity of a variety of models at different levels of non-urgent diagnoses. We also looked at continuous outcomes of NE, PCT, and NEPCT, which were the continuous probability of each category for all visits (averaged by week).

While the ED NYU Algorithm is widely utilized to determine urgency of ED visits in research studies, it is not without faults. The retrospective nature of a diagnosis has different implications than a patient’s chief complaint that brings them to the ED. As a result, the limitations of diagnosis-based performance measures in emergency medicine has been increasingly recognized. While diagnosis-based measures are advantageous in that they are readily available in large-scale patient data, such as claims data, they fail to measure risk stratification of symptoms. Elements of chief complaint measures that make them difficult for use as a performance measurement is that they are not standardized, so there is a lack of consensus on what terms to use and the level of granularity to use for conditions. They also vary across different EDs, nurses, and visits. (Griffey et al., 2015) Standardization of chief complaint terminology has been recommended by a Society for Academic Emergency Medicine consensus panel. (Haas et al., 2008) Additionally, while diagnosis codes are generally available in patient data, compilation of chief complaint data can be expensive, time consuming, and often require chart abstraction. (Griffey et al., 2015) Because of these limitations, we also explored Emergency Severity Index (ESI) as an outcome in the analysis.

b. <u>Emergency Severity Index (ESI)</u>

In addition to the NYU Algorithm, which uses diagnosis codes that are determined at the conclusion of the visit, we modelled the data using the ESI as an outcome. The ESI is a tool used by ED nurses to triage patients when they present to the ED and identify patients who cannot wait to be seen. It takes into account both acuity and resource needs, and prioritizes incoming patients and identifies patients who need to be seen immediately. (Gilboy et al., 2012) In the five levels of the ESI, smaller numbers signify a more urgent patient. One (1) is resuscitation (most urgent), 2 is emergent, 3 is urgent, 4 is less urgent, and 5 is nonurgent. Determination of the ESI level is based on four questions: “1. Does the patient require immediate life-saving care?, 2. Is this a patient who shouldn’t wait?, 3. How many resources (e.g., labs, imaging) will this patient need?, and 4. What are the patient’s vital signs?” (Gilboy et al., 2012) If the patient is dying, they are given a level of 1. If they are not dying but shouldn’t wait, they are given a 2. If it is ok for the patient to wait, the patient requires many resources, and they have no dangerous vital signs, they receive a score of 3. If the patient requires many resources and has dangerous vital signs, a score of 2 can be considered. If the patient can wait and needs one resource, they get a score of 4, and if they need no resources, they get a score of 5. (Gilboy et al., 2012) Use of the ESI allowed us to look at the urgency of the visit at the time of the patient's arrival to the ED, which may be a better indicator than the NYU algorithm of the initial urgency of the condition and/or the perceived severity of the condition by the patient. For our analysis, we combined ESI 1 and 2 (most urgent) and ESI 4 and 5 (least urgent) because there were very few ESI 1 and ESI 5 visits. We looked at visits with ESI 4 or 5 as our measure of non-urgent ED use our analysis.

TABLE XVIII. OUTCOME VARIABLES FOR CHAPTER III STUDY

j	**Outcomes**	**Definition/Example**
1 2 3 4 5 6	NE50 NE60 NE70 NE80 NE90 NE95	The percentage of ED visits with an ICD code with a probability that the diagnosis is Non-Emergent (NE) is 50% or greater (for NE50), based on the NYU Algorithm, out of all ED visits. Cutoff sensitivities were explored by changing the NE probability to ≥ 60% (NE60), 70% (NE70), 80% (NE80), 90% (NE90), and 95% (NE95).
7 8 9 10 11 12	PCT50 PCT60 PCT70 PCT80 PCT90 PCT95	The percentage of ED visits with an ICD code with a probability that the diagnosis is Primary Care Treatable (NE) is 50% or greater (for PCT50), based on the NYU Algorithm, out of all ED visits. Cutoff sensitivities were explored by changing the PCT probability to ≥ 60% (PCT60), 70% (PCT70), 80% (PCT80), 90% (PCT90), and 95% (PCT95).
13 14 15 16 17 18	NEPCT50 NEPCT60 NEPCT70 NEPCT80 NEPCT90 NEPCT95	The percentage of ED visits with an ICD code with a probability that the diagnosis is Non-Emergent plus that the diagnosis is Primary Care Treatable (NE) is 50% or greater (for NEPCT50), based on the NYU Algorithm, out of all ED visits. Cutoff sensitivities were explored by changing the NE+PCT probability to ≥ 60% (NEPCT60), 70% (NEPCT70), 80% (NEPCT80), 90% (NEPCT90), and 95% (NEPCT95).
19	NE	Continuous variable- probability values (%) for Non-Emergent (NE) category
20	PCT	Continuous variable- probability values (%) for Primary Care Treatable (PCT) category
21	NEPCT	Continuous variable- probability values (%) for Non-Emergent plus Primary Care Treatable (NE+ PCT)
22	ESI 4/5	The percentage of ED visits with an ESI 4 or 5, out of all ED visits.

Table XIX shows the unadjusted means for each outcome before and after the implementation of the ACA in January 2014. Z-tests of proportion was used for all outcomes except t-tests were used for continuous variables- mean NE, PCT, and NEPCT proportion of all visits. There were significant differences in several of the outcomes. For proportion of 50% non-emergent (NE), there were significantly more of these visits post-ACA compared to pre-ACA. There was also a higher mean probability for NE diagnoses in the post-period compared to the pre-period. For primary care treatable (PCT) diagnoses, there was a significantly higher proportion of 50% and 60% PCT visits after the ACA, compared to before. There was also a significantly higher mean PCT proportion for visits post-ACA compared to pre-ACA. Likewise, all of the levels of non-emergent + primary care treatable (NEPCT) proportions, except for 95% NEPCT, were higher for the post-period than the pre-period, including the mean NEPCT proportion for all visits. For ESI, the proportion of most urgent visits (ESI 1 or 2) and mid-urgent visits (ESI 3) significantly increased after ACA, whereas the proportion of least urgent visits (ESI 4 or 5) decreased after ACA. Overall, this data shows that non-urgent visits measured by the NYU Algorithm generally increased after the ACA, when not controlling for any covariates. Conversely, the proportion of non-urgent ESI visits decreased during this time.

Graphs of each outcome (counts and proportion) by week can be found in Figures 20-29, Appendix C, where the vertical line represents implementation of the ACA in January 2014.

F. <u>Research Design</u>

The research design was interrupted time series- at the week level over the time period of interest (January 2012- May 2017), with the intervention being comparison of the time period before and after implementation of the ACA. The interrupted time series method is a powerful

TABLE XIX. UNIVERSITY OF ILLINOIS HOSPITAL EMERGENCY DEPARTMENT NON-URGENT OUTCOME COMPOSITION (%) WITHOUT PATIENT COVARIATES-BEFORE AND AFTER IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)

Variable	Pre-ACA (Weeks 1-104) N= 54,410 visits	Post-ACA (Weeks 105-282) N= 101,634 visits	p-value[a]
% of Diagnoses with Non-Emergent Probability ≥50%	26.5	27.8	**0.016**
% of Diagnoses with Non-Emergent Probability ≥60%	24.5	24.4	0.845
% of Diagnoses with Non-Emergent Probability ≥70%	18.5	18.5	0.919
% of Diagnoses with Non-Emergent Probability ≥80%	6.1	5.7	0.453
% of Diagnoses with Non-Emergent Probability ≥90%	4.0	4.1	0.889
% of Diagnoses with Non-Emergent Probability ≥95%	3.4	3.2	0.671
Mean Non-Emergent Probability for All Visits	20.1	21.3	**0.000**
% of Diagnoses with Primary Care Treatable Probability ≥50%	20.0	22.1	**0.000**
% of Diagnoses with Primary Care Treatable Probability ≥60%	19.1	20.7	**0.002**
% of Diagnoses with Primary Care Treatable Probability ≥70%	3.4	4.0	0.259
% of Diagnoses with Primary Care Treatable Probability ≥80%	2.3	3.0	0.176
% of Diagnoses with Primary Care Treatable Probability ≥90%	1.4	1.9	0.383
% of Diagnoses with Primary Care Treatable Probability ≥95%	1.4	1.8	0.401
Mean Primary Care Treatable Probability for All Visits	23.3	24.6	**0.000**
% of Diagnoses with Non-Emergent+Primary Care Treatable Probability ≥50%	46.4	50.4	**0.000**
% of Diagnoses with Non-Emergent+Primary Care Treatable Probability ≥60%	45.7	49.6	**0.000**
% of Diagnoses with Non-Emergent+Primary Care Treatable Probability ≥70%	29.5	32.5	**0.000**
% of Diagnoses with Non-Emergent+Primary Care Treatable Probability ≥80%	27.9	29.6	**0.001**
% of Diagnoses with Non-Emergent+Primary Care Treatable Probability ≥90%	14.3	15.8	**0.004**
% of Diagnoses with Non-Emergent+Primary Care Treatable Probability ≥95%	9.1	9.1	0.940
Mean Non-Emergent+Primary Care Treatable Probability for All Visits	43.4	45.9	**0.000**
% of Visits with ESI 4 or 5	32.0	25.9	**0.000**

[a]Z-test of proportion was used for all variables except continuous variables (Mean Non-Emergent Probability for All Visits, Mean Primary Care Treatable Probability for All Visits, and Mean Non-Emergent+Primary Care Treatable Probability for All Visits), for which t-test was used.

quasi-experimental tool with many strengths for evaluating the effect of a policy change. (Penfold and Zhang, 2013; Wagner et al., 2002) It allows for testing of the level/intercept change and slope change associated with the policy change, while still controlling for the overall trend in the outcome of interest. (Penfold and Zhang, 2013) The interrupted time series study design was important to our research question because we wanted to determine how non-urgent ED utilization changed over time after implementation of the ACA.

We used the following model for interrupted time series analysis at the week level:

$$(5)\quad Y_t^{jg} = \beta_0^{jg} + \beta_1 Time_t + \beta_2^{jg} Post_t + \beta_3^{jg} Post_t Time_t + (\beta_4^{jg})' X_t + \epsilon_t^{jg}$$

In Equation (5), Y_t^{jg} was the proportion of non-urgent ED utilization across all visits by week as defined by multiple outcomes, where each outcome was defined by *j* (see Table XVIII). $Time_t$ was the elapsed time since start of study at weekly intervals (continuous variable). $Post_t$ was a dummy variable where 0 was pre-ACA implementation (January 2012 to December 2013) and 1 was post-ACA implementation (January 2014 to May 2017). $Post_t Time_t$ was an interactions of $Post_t$ and $Time_t$. The model was controlled for covariates (X_t): race (black, white, other), ethnicity (Hispanic, non-Hispanic), age group (19-29, 30-44, 45-64 (Based on CDC- Gindi, 2016)), gender (male, female), insurance type (Medicaid, uninsured, Medicare, private, other), arrival to ED during business hours (yes, no), zip code level poverty rate (continuous), and month (January-December). In the model, each outcome was notated as *j*, each group as *g*, and each week as *t*.

Coefficients of interest were β_2, which estimated the level change in non-urgent proportion of ED utilization post-ACA and β_3, which estimated the time trend change in non-urgent proportion of ED utilization trend post-ACA. Since the model was run at the week level, the outcomes and covariates were the mean proportion of each variable for the week. The model was run for the main dataset (all eligible 19-64 year old adult ED patients who lived in Illinois), and then for specific patient groups individually- only Medicaid patients, only private insurance patients, and only patients who arrived at the ED during business hours. Coefficients were estimated by ordinary least square (OLS) regression and used Newey-West standard errors.

G. Results

Tables XX through XXII show interrupted time series analysis by week for change in proportion of non-urgent visits after implementation of the ACA, controlling for ethnicity, gender, age, insurance type, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit. Table XX shows that there were no level or time trend changes for any level of NE visits after the start of the ACA. There were significant negative time trend changes for all thresholds of PCT visits except for 50% PCT. These changes ranged from -0.010 percentage points per week to -0.020 percentage points per week. There was also a significant time trend for 90% NEPCT of -0.023 percentage points per week. Based on the mean pre-ACA value of 14.3% of all ED visits being at least 90% NEPCT (from Table XIX), this time trend coefficient can be interpreted as a 0.16% decrease per week for 90% NEPCT visits after the ACA.

TABLE XX. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- PROPORTION NON-EMERGENT, PRIMARY CARE TREATABLE, AND NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISITS (% OF ALL VISITS AT 50%, 60%, 70%, 80%, 90% AND 95% NE, PCT, AND NEPCT)- ALL- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
B1 (Time)	-0.00609	-0.0137	-0.00623	-0.00278	0.00142	-0.000672
	(0.0130)	(0.0127)	(0.00943)	(0.00500)	(0.00385)	(0.00339)
B2 (Level Change)	0.735	0.902	0.725	-0.0352	-0.256	-0.363
	(1.135)	(1.085)	(0.885)	(0.419)	(0.339)	(0.305)
B3 (Time Trend Change)	-0.0116	-0.0213	-0.0159	-0.00911	-0.00435	-0.00315
	(0.0151)	(0.0147)	(0.0109)	(0.00559)	(0.00422)	(0.00373)
PRIMARY CARE TREATABLE (PCT) VISITS						
B1 (Time)	0.00816	0.0109	0.00538	0.00865**	0.00613**	0.00616**
	(0.00884)	(0.00880)	(0.00436)	(0.00363)	(0.00268)	(0.00267)
B2 (Level Change)	0.513	0.358	-0.104	-0.267	-0.155	-0.171
	(0.883)	(0.871)	(0.425)	(0.343)	(0.241)	(0.241)
B3 (Time Trend Change)	-0.0103	-0.0204**	-0.0112**	-0.00961**	-0.0104***	-0.0108***
	(0.00948)	(0.00948)	(0.00508)	(0.00414)	(0.00302)	(0.00299)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
B1 (Time)	0.00554	0.0103	0.00682	-0.000416	0.0109	-0.00227
	(0.0141)	(0.0144)	(0.0132)	(0.0132)	(0.00860)	(0.00616)
B2 (Level Change)	0.589	0.404	-0.334	0.0409	-0.0923	-0.748
	(1.328)	(1.351)	(1.128)	(1.141)	(0.721)	(0.560)
B3 (Time Trend Change)	-0.00741	-0.0164	-0.00881	-0.0215	-0.0228**	-0.0112
	(0.0169)	(0.0174)	(0.0152)	(0.0153)	(0.00974)	(0.00693)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit.

Table XXI shows that there was also a significant time trend change for the continuous mean PCT probability of -0.017 percentage points per week. Based on the mean for continuous PCT percentage before the ACA of 23.3% (from Table XIX), the coefficient for this time trend change can be interpreted as a 0.07% decrease per week in continuous mean PCT after the ACA. Since there were no level changes in the overall population, but there were significantly negative time trends in primary care treatable visits after the ACA, this suggests newly insured patients were able to eventually connect to primary care, as there was a decreasing proportion of visits over time that were seen in the ED but could have been seen in a primary care setting.

TABLE XXI. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- PROPORTION NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT), AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISITS BY CONTINUOUS MEAN (%)- ALL- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	NE	PCT	NEPCT
B1 (Time)	-0.00355	0.00694	0.00339
	(0.00942)	(0.00555)	(0.0110)
B2 (Level Change)	0.193	0.353	0.545
	(0.807)	(0.564)	(1.043)
B3 (Time Trend Change)	-0.00144	-0.0167***	-0.0181
	(0.0110)	(0.00628)	(0.0133)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit.

Table XXII shows no significant level or time trend change for proportion of patients with a non-urgent ESI.

TABLE XXII. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- NON-URGENT EMERGENCY SEVERITY INDEX (ESI) ASSIGNED AT TRIAGE -ALL- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	ESI 4 or 5
B1 (Time)	-0.0663***
	(0.0228)
B2 (Level Change)	-2.606
	(2.390)
B3 (Time Trend Change)	0.0464
	(0.0257)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit.

Figures 30-67, Appendix C show plots of the actual and predicted values of the outcome by week for any model that had a significant finding.

Tables XXIII through XXV show interrupted time series results for change in non-urgent ED utilization after the ACA by Medicaid patients. Table XXIII shows that Medicaid patients had level increases after the start of the ACA, especially for NE and NEPCT visits. Medicaid patients had level changes across all levels of NE visits, ranging from 0.74 percentage points for 95% NE visits to 4.02 percentage points for 60% NE visits. Likewise, Medicaid patients had level changes across all levels of NEPCT visits, ranging from 1.60 percentage points for 95%

NEPCT visits to 3.92 percentage points for 80% NEPCT visits. There was only one significant level change for PCT visits at 0.85 percentage points for 70% PCT visits.

Table XXIV shows that there were also significant level changes for the continuous means of NE (2.37 percentage points) and NEPCT (3.43 percentage points) visits. These findings suggest that after ACA, Medicaid patients immediately increased their non-emergent ED use across all NE levels. This usage was sustained, with no significant time trends for any non-urgent visit categories, which suggests that Medicaid patients may have had trouble connecting to outpatient settings for non-emergent needs. Table XXV shows no significant change in visits that were given a non-urgent ESI of 4 or 5.

Tables XXVI through XXVIII show interrupted time series results by week for change in non-urgent ED utilization for private insurance patients after the start of the ACA. Table XXVI shows that these patients had significant level change for 50%, 60%, and 70% NE, (2.10 percentage points, 2.85 percentage points, and 1.79 percentage points, respectively) with significant time trend change for 80% PCT visits (-0.01 percentage points per week). For NEPCT visits, private insurance patients had significant level changes after ACA for 50%, and 60% NEPCT visits, with significant time trend change of -0.02 percentage points per week for 90% NEPCT visits after the ACA. These findings suggest that, like Medicaid patients, private insurance patients had an immediate need for non-emergent ED care after ACA implementation. Since there were some negative time trends for categories of PCT and NEPCT visits, private insurance patients may have better connected to primary care, which decreased their PCT visits over time.

TABLE XXIII. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- PROPORTION NON-EMERGENT, PRIMARY CARE TREATABLE, AND NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISITS (% OF ALL VISITS AT 50%, 60%, 70%, 80%, 90% AND 95% NE, PCT, AND NEPCT)- MEDICAID PATIENTS- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
B1 (Time)	0.00115	-0.00584	-0.00917	-0.0137	-0.00915	-0.0107**
	(0.0161)	(0.0156)	(0.0122)	(0.00761)	(0.00590)	(0.00533)
B2 (Level Change)	3.632***	4.017***	3.187***	1.389***	0.926**	0.743**
	(1.112)	(1.073)	(0.922)	(0.527)	(0.398)	(0.365)
B3 (Time Trend Change)	-0.0136	-0.0228	-0.0148	0.00279	0.00656	0.00657
	(0.0170)	(0.0164)	(0.0128)	(0.00784)	(0.00624)	(0.00564)
PRIMARY CARE TREATABLE (PCT) VISITS						
B1 (Time)	0.0132	0.00974	-0.00131	0.00244	0.00176	0.00175
	(0.0106)	(0.0105)	(0.00495)	(0.00417)	(0.00322)	(0.00322)
B2 (Level Change)	0.598	0.723	0.852**	0.508	0.422	0.429
	(0.972)	(0.949)	(0.394)	(0.320)	(0.263)	(0.265)
B3 (Time Trend Change)	-0.00944	-0.0134	-0.000802	-0.00169	-0.00336	-0.00372
	(0.0120)	(0.0118)	(0.00554)	(0.00458)	(0.00370)	(0.00370)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
B1 (Time)	0.0133	0.0137	0.00159	-0.000872	-0.000203	-0.0162
	(0.0159)	(0.0163)	(0.0158)	(0.0159)	(0.0119)	(0.00944)
B2 (Level Change)	3.219***	3.204***	3.235***	3.922***	2.201***	1.603**
	(1.190)	(1.204)	(1.089)	(1.146)	(0.834)	(0.629)
B3 (Time Trend Change)	-0.00424	-0.00833	0.00503	-0.0137	-0.00526	0.00830
	(0.0174)	(0.0177)	(0.0167)	(0.0169)	(0.0127)	(0.0101)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit.

TABLE XXIV. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- PROPORTION NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT), AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISITS BY CONTINUOUS MEAN (%)- MEDICAID PATIENTS- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	NE	PCT	NEPCT
B1 (Time)	-0.00331	0.00508	0.00177
	(0.0121)	(0.00611)	(0.0128)
B2 (Level Change)	2.369***	1.055	3.425***
	(0.831)	(0.569)	(0.935)
B3 (Time Trend Change)	0.00195	-0.0130	-0.0110
	(0.0126)	(0.00703)	(0.0140)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit.

TABLE XXV. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- NON-URGENT EMERGENCY SEVERITY INDEX (ESI) ASSIGNED AT TRIAGE –MEDICAID PATIENTS- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	ESI 4 or 5
B1 (Time)	-0.0237
	(0.0198)
B2 (Level Change)	-2.011
	(1.732)
B3 (Time Trend Change)	0.0202
	(0.0212)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit.

TABLE XXVI. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- PROPORTION NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT), AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISITS (% OF ALL VISITS AT 50%, 60%, 70%, 80%, 90% AND 95% NE, PCT, AND NEPCT)- PRIVATE INSURANCE PATIENTS- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
B1 (Time)	-0.0201	-0.0313**	-0.0153	0.00341	0.00486	0.00112
	(0.0147)	(0.0146)	(0.0122)	(0.00665)	(0.00538)	(0.00510)
B2 (Level Change)	2.104**	2.845***	1.789**	0.491	0.289	0.322
	(1.008)	(1.017)	(0.871)	(0.434)	(0.404)	(0.367)
B3 (Time Trend Change)	0.0164	0.00997	0.00514	-0.0129	-0.00730	-0.00476
	(0.0159)	(0.0157)	(0.0131)	(0.00696)	(0.00572)	(0.00539)
PRIMARY CARE TREATABLE (PCT) VISITS						
B1 (Time)	0.0132	0.00980	0.00656	0.0109**	0.00620	0.00622
	(0.0113)	(0.0115)	(0.00579)	(0.00474)	(0.00392)	(0.00391)
B2 (Level Change)	1.137	1.427	0.471	0.110	0.231	0.245
	(0.868)	(0.848)	(0.429)	(0.374)	(0.284)	(0.284)
B3 (Time Trend Change)	-0.00805	-0.0136	-0.00927	-0.0105**	-0.00649	-0.00686
	(0.0124)	(0.0126)	(0.00626)	(0.00529)	(0.00429)	(0.00429)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
B1 (Time)	-0.00299	-0.00501	-0.00604	-0.00868	0.0252**	0.00240
	(0.0159)	(0.0157)	(0.0156)	(0.0151)	(0.0108)	(0.00843)
B2 (Level Change)	2.358**	2.531**	1.432	1.996	0.235	0.158
	(1.134)	(1.128)	(1.048)	(1.047)	(0.716)	(0.608)
B3 (Time Trend Change)	0.0200	0.0173	0.0209	0.00607	-0.0246**	-0.00593
	(0.0173)	(0.0170)	(0.0164)	(0.0160)	(0.0112)	(0.00884)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit.

Table XXVII shows that the continuous probability for PCT and NEPCT conditions also had a significant positive level change after the ACA. This level change was sustained across the study period with no significant change in time trend.

TABLE XXVII. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- PROPORTION NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT), AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISITS BY CONTINUOUS MEAN (%)- PRIVATE INSURANCE PATIENTS- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	NE	PCT	NEPCT
B1 (Time)	-0.0119	0.00389	-0.00797
	(0.0110)	(0.00805)	(0.0129)
B2 (Level Change)	1.154	1.211**	2.365***
	(0.753)	(0.573)	(0.896)
B3 (Time Trend Change)	0.0168	-0.00692	0.00984
	(0.0117)	(0.00867)	(0.0139)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit.

Table XXVIII shows that there was a significant negative level change in being assigned an ESI of 4 or 5 (least urgent) at arrival to the ED. This may suggest that, compared to before the ACA, these patients may have been coming to the ED with conditions that appeared more urgent at the start of the visit or required multiple resources or tests, which would warrant a more urgent ESI value. Paired with the findings from Tables XXVI and XXVII, these patients may have presented to the ED with more urgent conditions that could have been treated in a primary care setting (the definition of primary care treatable visits in the NYU Algorithm).

TABLE XXVIII. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- NON-URGENT EMERGENCY SEVERITY INDEX (ESI) ASSIGNED AT TRIAGE –PRIVATE INSURANCE PATIENTS- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	ESI 4 or 5
B1 (Time)	-0.00620
	(0.0177)
B2 (Level Change)	-6.143***
	(1.501)
B3 (Time Trend Change)	-0.0115
	(0.0192)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, whether arrival to ED occurred during business hours, zip code level poverty rate, and month of visit.

Finally, Tables XXIX through XXXI show changes after the ACA using interrupted time series analysis by week for patients who arrived at the ED during business hours. Table XXIX shows that patients who arrived to the ED during business hours had significant level changes of 2.58 percentage points, 3.33 percentage points, and 2.06 percentage points for 50%, 60%, and 70% NE visits, respectively. These patients had a significant time trend change of -0.02 percentage points per week for 60% PCT visits after ACA, with no significant findings for NEPCT visits.

Table XXX shows that the time trend change for continuous probability of PCT visits changed by -0.02 percentage points per week after the ACA. If patients arrived to the ED during business hours, this meant that other alternatives for care, such as doctor's offices and clinics, were likely open at that time. These patients may have initially needed the ED for non-emergent needs while they connected themselves to outpatient care, at which time the time trend for their PCT visits decreased over time.

TABLE XXIX. INTERRUPTED TIME SERIES ANALYSIS BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- PROPORTION NON-EMERGENT, PRIMARY CARE TREATABLE, AND NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISITS (% OF ALL VISITS AT 50%, 60%, 70%, 80%, 90% AND 95% NE, PCT, AND NEPCT)- PATIENTS WHO ARRIVED TO ED DURING BUSINESS HOURS- JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
B1 (Time)	-0.0209	-0.0242	-0.0110	-0.00517	-0.00426	-0.00422
	(0.0150)	(0.0141)	(0.0107)	(0.00658)	(0.00604)	(0.00515)
B2 (Level Change)	2.581**	3.326***	2.061**	0.409	0.344	0.199
	(1.227)	(1.176)	(0.936)	(0.532)	(0.478)	(0.428)
B3 (Time Trend Change)	0.00687	-0.00889	-0.0108	-0.00827	-0.000932	-0.000570
	(0.0164)	(0.0155)	(0.0118)	(0.00720)	(0.00640)	(0.00553)
PRIMARY CARE TREATABLE (PCT) VISITS						
B1 (Time)	0.0166	0.0153	-0.00166	0.00417	0.00279	0.00286
	(0.00977)	(0.00995)	(0.00541)	(0.00459)	(0.00345)	(0.00344)
B2 (Level Change)	-0.406	-0.160	0.343	0.222	0.246	0.211
	(1.024)	(0.991)	(0.516)	(0.414)	(0.291)	(0.292)
B3 (Time Trend Change)	-0.0180	-0.0224**	-0.00117	-0.00149	-0.00383	-0.00437
	(0.0112)	(0.0112)	(0.00615)	(0.00516)	(0.00379)	(0.00376)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
B1 (Time)	-0.00452	-0.00155	-0.0156	-0.0178	0.00557	-0.00728
	(0.0179)	(0.0181)	(0.0159)	(0.0154)	(0.0112)	(0.00804)
B2 (Level Change)	1.530	1.505	1.502	2.379	1.079	0.0540
	(1.501)	(1.485)	(1.301)	(1.233)	(0.893)	(0.643)
B3 (Time Trend Change)	0.00873	0.00332	0.0220	0.00275	-0.0142	-0.00376
	(0.0197)	(0.0200)	(0.0173)	(0.0165)	(0.0120)	(0.00851)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, zip code level poverty rate, and month of visit.

TABLE XXX. INTERRUPTED TIME SERIES BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- PROPORTION NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT), AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISITS BY CONTINUOUS MEAN (%)-PATIENTS WHO ARRIVED TO ED DURING BUSINESS HOURS - JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	NE	PCT	NEPCT
B1 (Time)	-0.0148	0.00868	-0.00607
	(0.0108)	(0.00736)	(0.0144)
B2 (Level Change)	1.557	-0.172	1.385
	(0.871)	(0.656)	(1.178)
B3 (Time Trend Change)	0.0120	-0.0167**	-0.00475
	(0.0119)	(0.00829)	(0.0157)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, zip code level poverty rate, and month of visit.

Table XXXI shows that there was a significant level change of -6.19 percentage points for visits where ESI was assigned as 4 or 5 after ACA, compared to before. This may again be a case of patients presenting to the ED with more apparently severe conditions that might have required more testing or resources, but their eventual diagnosis may have been less severe than initially predicted (since there were also significant positive level changes for non-emergent visits in this group).

H. **Discussion**

We had hypothesized that the level change in proportion of non-urgent ED visits at UI Hospital would increase and the time trend change in non-urgent ED visits at UI Hospital would decrease. Based on qualitative data from people who changed from uninsured to insured (Artiga et al., 2015), we proposed that the uninsured tend to avoid the ED because of costs, so initial non-urgent ED use will increase because cost barriers would be relieved from the new insurance. However the newly insured would need time to connect to the outpatient setting and may have

TABLE XXXI. INTERRUPTED TIME SERIES BY WEEK FOR IMPLEMENTATION OF THE AFFORDABLE CARE ACT (ACA)- NON-URGENT EMERGENCY SEVERITY INDEX (ESI) ASSIGNED AT TRIAGE - PATIENTS WHO ARRIVED TO EMERGENCY DEPARTMENT DURING BUSINESS HOURS - JANUARY 2012-MAY 2017 (282 WEEKS)[a, b]

VARIABLES	ESI 4 or 5
B1 (Time)	-0.0144
	(0.0218)
B2 (Level Change)	-6.185***
	(2.047)
B3 (Time Trend Change)	0.000140
	(0.0248)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, zip code level poverty rate, and month of visit.

pressing/worsening conditions as a result of avoiding care so will initially seek care in the ED. We also proposed that longer term time trend change in non-urgent ED use would decrease because once primary and specialty care were established, care would be received in an outpatient setting rather than the ED.

Amongst all of our interrupted time series findings that used NYU Algorithm outcomes, all level changes after ACA were positive and all time trend changes after ACA were negative. This general pattern supported our hypothesis that initial non-urgent care would initially increase, and then decrease over time. This finding suggests that after ACA, newly insured patients were able to eventually connect to primary care, therefore decreasing the proportion of visits that were seen in the ED but could have been seen in a primary care setting.

However, significance of level and time trend changes varied by patient group. Looking at all patients overall, there were no level changes. There were negative time trend changes across most levels of PCT visits and one level of NEPCT visits, which might have been driven by the change in PCT visits. Since there were no significant level changes in the overall population, patients may have generally been able to connect to outpatient settings quickly and continuously after the start of the ACA, and the use of the ED for primary care treatable visits decreased over time.

Medicaid patients had a very different post-ACA change compared to the general ED population. They only had significant positive level changes, and the changes were across all levels of NE and NEPCT (likely due to the influence of the NE visits) visits. This meant that there was an increase in Medicaid patient who presented to the ED with non-emergent needs immediately following the start of the ACA. There were no significant time trend changes, so these increases were sustained over the study period. This was the only patient sub-group in our analysis that did not support the hypothesis that non-urgent visits decreased over time after the implementation of the ACA.

For private insurance patients, there were positive level changes for some NE and NEPCT visit levels, as well as negative time trend change for 80% PCT and 90% NEPCT visits. There were also positive level changes for continuous means of PCT and NEPCT visits. Like the Medicaid patients, private insurance patients had sustained, higher NE visits after implementation of the ACA, suggesting that these patients were not shifting care to outpatient settings after ACA implementation. However, unlike Medicaid patients, private insurance patients had negative time trends for a PCT visit level and a NEPCT visit level, which suggests that for they may have shifted care to the primary care setting over time, after the implementation of the ACA.

In comparing Medicaid and private insurance patients, both subsets had positive level changes in NE and NEPCT ED visits after ACA. There were more significant positive level increases, with greater magnitudes, for Medicaid patients than other types of patients, and Medicaid patients had no significant negative time trends. Patients with private insurance may have been more likely to connect to primary care than Medicaid patients because of a greater out-of-pocket copay for them to use the ED compared to a doctor's office. For Illinois Medicaid patients, in 2018, the co-pay for an emergency room visit in a non-emergency and copay for a physician/clinic visit are both $3.90. (Illinois Department of Human Services, n.d.) While there are numerous private insurance plans, one private open access insurance plan for State of Illinois employees had a minimum $20 copay for a primary care visit to a doctor's office and a $250 copay for each ED visit. (State of Illinois, 2018) This large difference between the cost of a doctor's office visit versus an ED visit for private insurance patients, compared to no difference between the cost of these visits for a Medicaid patient may explain these findings. Another explanation is that Medicaid patients may have had a more difficult time finding outpatient doctors who accept Medicaid insurance, so it may have been a challenge to get an appointment with a doctor due to a lack of capacity.

We also looked at patients who arrived to the ED during business hours and found that these patients had significant positive level changes for NE visits and negative time trend for PCT visits. Patients who arrived to the ED during business hours arrived when other alternatives for care, such as doctor's offices and clinics, were likely open at that time. These patients may have initially needed the ED for non-emergent needs while they connected themselves to outpatient care, at which time the time trend for their PCT visits decreased over time.

In looking at ESI, we found a significant negative level change in being assigned an ESI of 4 or 5 (least urgent) at arrival to the ED after ACA for patients with private insurance and those who arrived to the ED during business hours. These subsets of patients also had positive level changes for NE visits. This may suggest that, compared to before the ACA, these patients may have arrived to the ED with conditions that appeared more urgent at the start of the visit or required multiple resources or tests, which would have warranted a more urgent ESI value. Although patients presented with more severe-appearing conditions, they were more likely to eventually be diagnosed with conditions that were non-emergent.

In returning to Figure 12 in the Methods section, we can see that during our study period, the number of outpatient visits at the UI Hospital system trended upward. It is possible that newly covered patients were able to eventually connect to outpatient care within the UI Hospital system. This follows the negative time trend for PCT visits for the overall patient population, and suggests that over time patients are connecting to outpatient care, rather than going to the ED for concerns that could be treated in a primary care setting.

Our findings support previous published literature on non-urgent ED visits after increased insurance coverage. Several studies found that non-urgent ED utilization increased after increased insurance coverage. The authors of the Oregon Medicaid expansion (2008) analysis found that the greatest increases after receiving coverage, of the 40% increase in ED visits, were for visits that were primary care treatable and non-emergent. (Taubman et al., 2014) Garthwaite et al, 2017 found that after Medicaid expansion, visits for non-emergent conditions increased by 129.7% among Medicaid patients and Medicaid visits increased by 146.9% for primary care treatable visits in expansion states. (Garthwaite et al, 2017) At the county level, in California from 2012 to 2015, rates of preventable ED visits increased by 10.9%. (Cunningham & Sheng, 2018) However, one study of the Massachusetts insurance reform of 2006, which included a more state wide reform than just Medicaid expansions, showed that increased insurance coverage reduced ED visits by 5-8%, nearly all of which was for non-urgent visits. (Miller, 2012) The magnitude of our findings were closer to Cunningham & Sheng's (2018) findings, because we looked at rates and not change in number of visits (such as Garthwaite et al., 2017).

In reviewing these studies, it appears that length of time for the post-period analysis may affect the direction of the findings. For the studies that found increases in non-urgent ED utilization (Cunningham and Sheng, 2018; Garthwaite et al., 2017; Taubman et al., 2014), all had one to two year post-expansion periods. The study that had a decrease in non-urgent ED utilization (Miller, 2012), had the longest post-expansion analysis period of three years. Based on our findings that non-urgent ED utilization initially increased and then decreased over time, along with our post-ACA analysis period of 3 ½ years, it may be that having a longer post period affords more time to see non-urgent ED utilization decrease.

Additionally, the varied findings in prior literature may be a result of varying definitions of non-urgent ED use. A 2013 systematic review of 26 articles on visiting the ED for non-urgent conditions found that each article had a different definition of non-urgent visits. (Uscher-Pines et al., 2013) The proportion of all ED visits found to be non-urgent across the articles ranged from 8-62%, with an average of 37%. (Uscher-Pines et al., 2013) While the ED NYU Algorithm is widely utilized to determine urgency of ED visits in research studies, the definitions used in each vary. For example in Garthwaite et al., 2017 and Taubman et al.'s studies, the authors grouped diagnoses into NYU Algorithm categories based on the predominant probability of each group for each diagnosis. Miller (2012) used the NYU Algorithm but used the continuous probability per group for each category (as a continuous variable rather than a binary variable for each category). Our analysis used many different outcomes, at several different cut points, in order to explore different definitions for "non-urgent" conditions. If we had used fewer outcomes, we would have likely found fewer significant findings.

This study had several limitations. First, the analysis was a single-group interrupted time series design, which is inferior to a design with a comparable control group as a counterfactual. There are some possible threats to validity of our interrupted time series analysis that we could not avoid. Use of a comparable group allows for observation of any factors other than the intervention that shift the time series to be seen in both groups (History threat). As a result, the use of two groups could eliminate the History threat to validity and without a comparison group it is difficult to confirm with certainty that an event outside the intervention is not mistaken for a treatment effect. (Linden, 2017) Since this study does not have a control group, we cannot rule out the History threat in our analysis.

Another threat to interrupted time series analysis is Selection, which can bias the analysis if the composition of the study group is different before and after the introduction of the intervention. (Shadish et al., 2002) Since our intervention was a change in insurance coverage for patients, this changed the composition of patients who had each type of insurance. There was also a difference in gender, age, and poverty level for our study group before and after ACA, so we must recognize that the composition of patients before and after the intervention were not the same, which was a limitation of our data. To best account for this threat, we controlled for all pertinent observable patient variables- including gender, age, and poverty level, in our models.

Other studies, such as those that have evaluated the excise tax on sugar sweetened beverages in Mexico (Colchero et al., 2016), have also used single group interrupted time series. These authors acknowledge that causality cannot be established from the work of a single group interrupted time series model because there are likely other changes occurring concurrently with the intervention of the beverage tax.

Additionally, our study only used data from one hospital. The hospital was within the Illinois Medical District of Chicago- which also includes a public hospital, a private teaching hospital, and a Veterans Affairs hospital. This analysis did not take into account any data from other hospitals. It is possible that uninsured patients at UI Hospital change preferences to use a different hospital once they receive insurance. We had no way of knowing if patients switched hospitals after receiving insurance through ACA. As a result, we were limited in our analysis to only look at the change in proportion of non-urgent visits to the UI Hospital ED. While our post-ACA period was the longest that could be found in the literature at the time of analysis, we were unable to observe longer-term outcomes from the ACA, which may be welfare improving. Future work could explore the effects of longer-term outcomes from the ACA.

In conclusion, our NYU Algorithm outcome findings suggest that all level changes after the ACA were positive and all time trend changes after the ACA were negative. This general pattern supported our hypothesis that initial non-urgent care would initially increase, and then decrease over time. However, Medicaid patients sustained their increase in non-urgent ED visits over time, whereas private insurance patients had negative time trend results for some non-urgent thresholds. The difference between these two groups may suggest that Medicaid patients may not connect to outpatient care at the capacity of private insurance patients. Private insurance patients may seek outpatient care because of a difference in copay costs for outpatient visits versus ED visits that is not present for Medicaid patients. Also, Medicaid patients may have difficulty finding health care providers that take Medicaid insurance. Furthermore, our findings had the longest post-expansion period (3 ½ years) of any other study we could find on the association between increased insurance coverage and non-urgent ED utilization, which may show a more complete picture of long and short-term effects of the ACA on non-urgent ED use.

More research that expands the data to a wider reach of hospitals and outpatient sites, and includes a comparison group, would be beneficial to obtain causal findings.

IV. CONCLUSIONS

Chapter I evaluated the EPIC program- an individualized care coordination intervention program for frequent visitors of the emergency department. The indication that EPIC program participants increased ED utilization after the program, compared to comparison patients was a new finding in this field. Future studies with strong analytical methods are warranted to determine if there is replication of this finding in other studies. This study exhibits the importance of including a comparison group and having access to data that covers a larger geographical area than only one hospital in order to truly see the effect of the program on its participants. It was possible that program participants may have felt more comfortable or satisfied with their care in the ED because of the program, and future programs that target frequent ED visitors but are physically located in an outpatient setting may be more likely to see a shift in utilization from the ED to the outpatient setting. Patients who frequented multiple EDs before the program may have consolidated their care to only the UI Hospital ED after participation in the program. As a result, obtaining data that provides visits for all patients across all sites of care would be a necessary next step to determining if our interpretation of these findings is accurate.

Chapter II explored the association between distance to closest federally qualified health center (FQHC) and Medicaid and uninsured patients' utilization of the ED of UI Hospital for non-urgent health care needs. Findings suggested that a decrease in distance to the closest FQHC purely induced by a new FQHC opening near patients' residences between the period February 2009 and July 2011 was generally not associated with a change in non-urgent ED visits within our study's geographic coverage (i.e., within 9 miles surrounding of the UI Hospital ED) and during our study period. In sub-analyses, there were some significant associations when the sample was stratified by certain distance characteristics, however these findings did not all follow the same direction for the association. Healthcare utilization is complex and patients may actually prefer to travel longer distances to receive hospital care over outpatient care at an FQHC.

This study had many limitations and as a result should be considered exploratory. Future research that uses data that includes visits to multiple EDs and visits to FQHCs and other primary care settings utilized by this patient population would provide better evidence to determine if there is truly no relationship between FQHC distance and non-urgent ED utilization, as it would give the full extent of patients' health care utilization. Additionally, more data on specific characteristics of each FQHC, including services available (such as lab tests and imaging), operating days and hours (such as operation on the weekends), and quality indicators, could provide a better picture of patient preferences for using certain FQHC sites. Use of the ED for non-emergent issues is expensive, and further research is warranted to determine how to improve access to lower cost options such as FQHCs.

Chapter III aimed to determine if the proportion of non-urgent ED utilization changed at UI Hospital in after the Affordable Care Act (ACA) of 2010. The NYU Algorithm outcome findings suggested that all level changes after the ACA were positive and all time trend changes after the ACA were negative. This general pattern supported our hypothesis that initial non-urgent care would initially increase, and then decrease over time. However, Medicaid patients sustained their increase in non-urgent ED visits over time, whereas private insurance patients had negative time trend results for some non-urgent thresholds. The difference between these two groups may suggest that Medicaid patients may not connect to outpatient care at the capacity of private insurance patients. Private insurance patients may seek outpatient care because of a difference in copay costs for outpatient visits versus ED visits that is not present for Medicaid patients. Also, Medicaid patients may have difficulty finding health care providers that take Medicaid insurance. Furthermore, our findings had the longest post-expansion period (3 ½ years) of any other study we could find on the association between increased insurance coverage and non-urgent ED utilization, which may show a more complete picture of long and short-term effects of the ACA on non-urgent ED use. More research that expands the data to a wider reach of hospitals and outpatient sites, and includes a comparison group, would be beneficial to obtain causal findings.

APPENDICES

APPENDIX A

Sub-Analysis of Intervention and Comparison Groups Based on Their Arrival Time to the Emergency Department

Recruitment for the EPIC program took place on weekdays (Monday through Friday) from 9am to 5pm. We looked at the time of arrival to the ED for all patients enrolled in the EPIC program and found that the patient enrolled closest to the time that enrollment ended (5pm) arrived at 4:06pm. Due to the time it takes to register at the ED and wait in the waiting room for care, there were no EPIC patients who arrived between 4:07 and 5:00pm because recruitment took place in the ED, so patients arriving to the ED during this period would not have had time to get into the ED before 5pm.

For this sub-analysis we took a subset of patients eligible for the main analysis and created two new intervention and comparison groups based on the time the patient arrived to the ED. The intervention group was patients who were enrolled into the EPIC program who arrived to the ED from noon to 4:06pm. The comparison group was patients who were eligible for the EPIC program but were never approached for the program and arrived to the ED from 4:15-4:59pm. A comparison group of patients who arrived from 4:15-4:59pm allows for the most similar characteristics of comparison group patients to intervention patients because this time period, like EPIC enrollment, is during the business day, when other health care facilities (such as doctor's offices) are also open. Also, patients who have full-time jobs are likely working until approximately 5pm. The purpose of this sub-analysis was to see if a DID model comparing these two groups showed similar findings as our main DID model that used groups that were created using propensity score matching.

APPENDIX A (continued)

Figure 16 shows the number of EPIC participants and number of patients eligible for EPIC but never approached by the EPIC team by hour of arrival. Figure 17 shows the percent of patients within each group (1. EPIC participants and 2. Patients eligible for EPIC but never approached by the EPIC team) who arrived at the ED for each hour. For non-participants, arrival to the ED was relatively constant across all hours, with most arriving in the 4pm hour and the least arriving in the 6am hour. For participants, arrival to the ED was greatest in the mid-morning hours (eg. 8am-noon). Based on the data, there were far fewer patients enrolled for the EPIC program than who were eligible. For example, the percentage of EPIC participants was highest for arrival at 9am than any other time. Arrival to the ED in the 9am hour occurred for 48 EPIC participants and 152 eligible, non-participants.

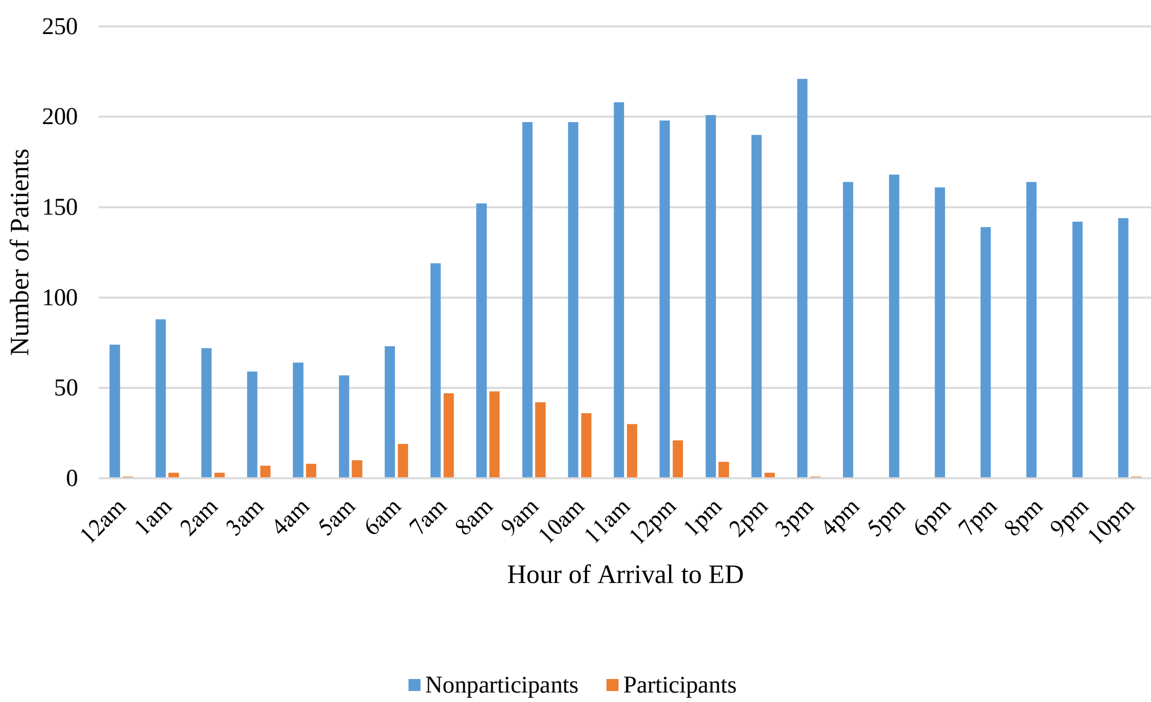
In a perfect scenario, patient characteristics would be random (not statistically different) for these two groups, so we determined if there were any significant differences in their observable characteristics. Table XXXII shows the patient characteristics of the intervention group (EPIC participants who were enrolled into the EPIC program on a weekday when they arrived at the ED from 12-4:06pm) and the comparison group (ED patients who were eligible for the EPIC program but who were never approached about the EPIC program and arrived at the ED from 4:15-4:59pm on a weekday).

Based on Table XXXII, there were some significant differences between these two groups. There were significantly more African American patients in the intervention group and more Hispanic patients in the comparison group. There were significant differences in number

APPENDIX A (continued)

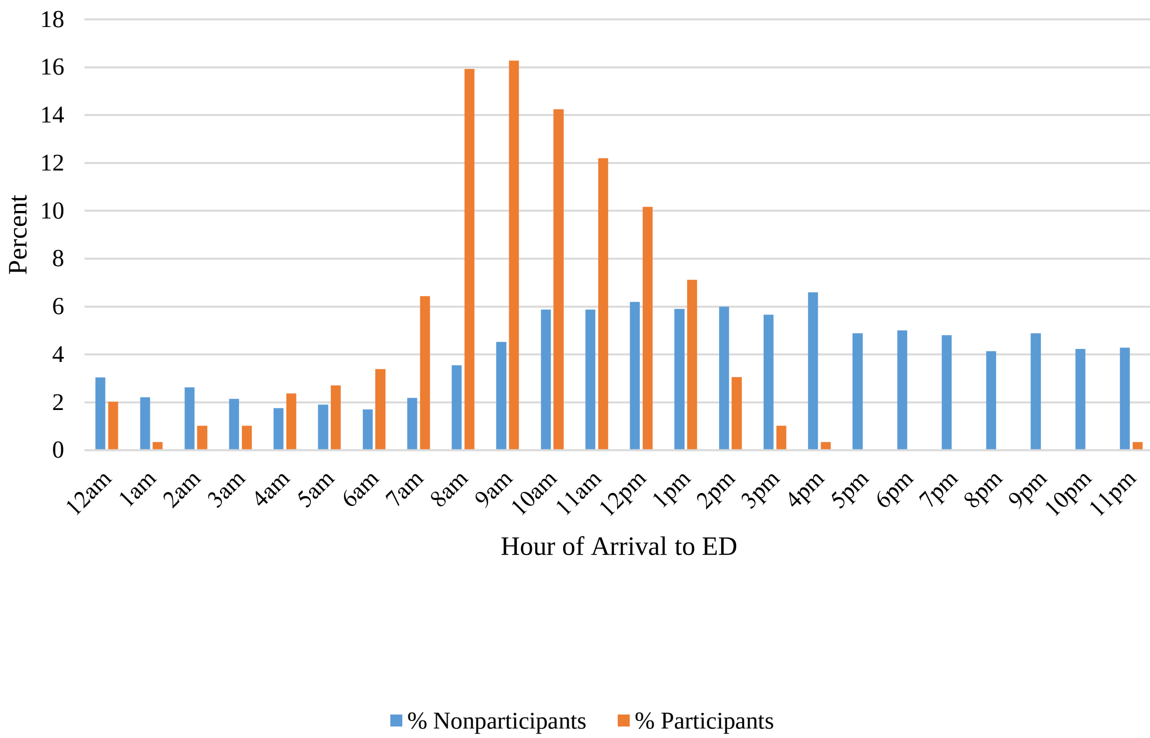
of pre-program ED visits, with a higher proportion of patients in the low group for the intervention group than the comparison group. There was also a significantly lower proportion of patients with a medium number of pre-ED visits in the intervention than the comparison group.

Figure 16. Number of Emergency Patient Interdisciplinary Care (EPIC) Participants and Eligible Non-Participants by Hour of Arrival to Emergency Department (Weekdays During Months of Emergency Patient Interdisciplinary Care (EPIC) Program Recruitment)



APPENDIX A (continued)

Figure 17. Percent of Emergency Patient Interdisciplinary Care (EPIC) Participants and Eligible Non-Participants by Hour of Arrival to Emergency Department (Weekdays During Months of Emergency Patient Interdisciplinary Care (EPIC) Program Recruitment)



APPENDIX A (continued)

TABLE XXXII. CHARACTERISTICS OF EMERGENCY DEPARTMENT PATIENTS WHO PARTICIPATED IN EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM AND ARRIVED TO EMERGENCY DEPARTMENT FROM NOON TO 4:06PM ON DAY OF ENROLLMENT VERSUS EMERGENCY DEPARTMENT PATIENTS ELIGIBLE FOR THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM WHO WERE NEVER APPROACHED AND ABOUT THE PROGRAM AND ARRIVED TO THE EMERGENCY DEPARTMENT BETWEEN 4:15 AND 4:59PM[a]

Patient Characteristics	Intervention Group: EPIC Participants Who Arrived at ED Noon-4:06pm during Weekdays for Visit of EPIC Enrollment, N=64	Comparison Group: ED Patients Eligible for EPIC who were Never Approached for EPIC Who Arrived at ED 4:15-4:59pm on Weekdays, N=197	p-value[b]
Race			
% African American	81.3	60.0	**0.002**
% White	9.4	10.3	0.839
% Other	9.4	29.7	**0.001**
Ethnicity			
% Hispanic	9.7	24.7	**0.012**
Age, Mean (Standard Deviation)	47.8 (15.2)	47.0 (16.5)	0.750
Gender			
% Female	54.7	64.0	0.185
Insurance Type			
% Medicaid	50.0	45.2	0.502
% Private	9.4	14.2	0.318
% Uninsured	10.9	13.7	0.568
% Medicare	25.0	26.4	0.825
% Other	3.1	0.5	0.088
ED Visits 6 Months Pre-Program, Mean (Standard Deviation)	75.0	35.5	**0.000**
% Low (0-4 visits)	9.4	39.6	**0.000**
% Medium (5-7 visits)	15.6	24.9	0.124
% High (8+ visits)			
Inpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	1.5 (1.6)	1.5 (2.0)	0.936
Outpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	6.9 (8.8)	6.1 (6.6)	0.434
% Homeless	12.5	6.6	0.132
% Sickle Cell Disease	10.9	8.6	0.579
Poverty Level for Patient's Census Tract			
% Low	37.1	31.9	0.451
% Medium	25.8	37.8	0.085
% High	37.1	30.3	0.319

[a] Patients in intervention group are unique patients, whereas patients in comparison group may include multiple visits by the same patient.
[b] Using Z-test of proportions for all except t-test for Inpatient visits, Outpatient visits, and Age (continuous).

APPENDIX A (continued)

For the DID analysis, we used the same covariates as the main analysis except we did not control for duration of program participation because the comparison group had no matches, so they could not mirror the duration of their matched intervention patient, as they did in the main analysis.

The lack of matching also posed some difficulty for defining the length of outcome measurement. In the main analysis, each individual in the comparison group used the start and end months of their matched intervention pair, since the dates and length of program participation varied by each individual. For this analysis, without matches, we had to use a general rule that applied to everyone in terms of start and end date of the outcome variables. To this end, the 6 month post-program period began the month after program enrollment (for the intervention group)/program eligibility (for the comparison group) and ended 6 months after this month. The 10 month post-program period ended 10 months after this month. Thirty-nine (39) intervention patients (67%) completed their program interventions in their enrollment month. (For example, if a patient was enrolled in September 2013, their interventions only lasted through September 2013.) Nineteen (19) intervention patients had interventions that extended beyond their enrollment month. Average length for these patients was 280 days. While most patients in the intervention group had interventions that only occurred in their enrollment month, the analysis may bias the results for patients who are in the program for longer periods of time.

Additionally, like in the main analysis, we limited our analysis to those who had at least one ED, outpatient, or inpatient visit in the 10 month post-period, which caused us to delete 18

APPENDIX A (continued)

patients from the dataset (6 intervention patients and 12 comparison patients). These patients were removed because we presumed died, moved, or shifted care to another health system.

This left us with a final sample size of 58 intervention patients and 185 comparison patients. A comparison of observable variables in the new sample can be found in Table XXXIII. Table XXXIII shows that the same covariates remained significant from Table XXXII, with the additional significant difference in patients who were homeless. There were significantly more homeless patients in the intervention group than the comparison group.

Tables XXXIV and XXXV show the results of the DID analysis using this sample. Similar to the findings from the main analysis, for the time period of the pre-EPIC period versus the post-periods, there were significant increases of ED visits for the intervention group compared to the comparison group. These results had a higher magnitude of visits for each post-program time period compared to the main analysis, although the samples were different. In the main analysis, the increase in ED visits for all participants (not stratified by intervention intensity level) in the EPIC program was 2.5 visits compared to the comparison group in the pre-period versus the 6 month post-period, versus 3.2 visits in the sub-analysis. In the 10 month main analysis, there was a significant increase of 2.9 ED visits for the pre-period versus the post-period for the intervention group compared to the comparison group, compared to a significant increase of 3.8 visits for the sub-analysis. Also similar to the main analysis, there were no significant DID estimates for inpatient or outpatient visits.

APPENDIX A (continued)

TABLE XXXIII. CHARACTERISTICS OF EMERGENCY DEPARTMENT PATIENTS WHO PARTICIPATED IN EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM AND ARRIVED TO EMERGENCY DEPARTMENT FROM NOON TO 4:06PM ON DAY OF ENROLLMENT VERSUS EMERGENCY DEPARTMENT PATIENTS ELIGIBLE FOR THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM WHO WERE NEVER APPROACHED AND ABOUT THE PROGRAM AND ARRIVED TO THE EMERGENCY DEPARTMENT BETWEEN 4:15 AND 4:59PM-PATIENTS WITH NO 10 MONTH VISITS REMOVED[a]

Patient Characteristics	Intervention Group: EPIC Participants Who Arrived at ED Noon-4:06pm during Weekdays for Visit of EPIC Enrollment, N=58	Comparison Group: ED Patients Eligible for EPIC who were Never Approached for EPIC Who Arrived at ED 4:15-4:59pm on Weekdays, N=185	p-value[b]
Race			
% African American	81.0	59.5	**0.003**
% White	8.6	9.7	0.801
% Other	10.3	30.8	**0.002**
Ethnicity			
% Hispanic	10.7	25.3	**0.022**
Age, Mean (Standard Deviation)	47.6 (15.6)	46.9 (16.4)	0.761
Gender			
% Female	56.9	64.3	0.308
Insurance Type			
% Medicaid	44.8	46.5	0.825
% Private	10.3	15.1	0.359
% Uninsured	12.1	13.0	0.857
% Medicare	27.6	24.9	0.678
% Other	3.4	0.5	0.080
ED Visits 6 Months Pre-Program, Mean (SD)			
% Low (0-4 visits)	74.1	35.1	**0.000**
% Medium (5-7 visits)	10.3	39.5	**0.000**
% High (8+ visits)	15.5	25.4	0.119
Inpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	1.5 (1.7)	1.5 (2.0)	0.891
Outpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	7.3 (9.0)	6.4 (6.7)	0.417
% Homeless	13.8	5.4	**0.033**
% Sickle Cell Disease	12.1	9.2	0.521
Poverty Level for Patient's Census Tract			
% Low	37.5	33.1	0.550
% Medium	25.0	37.1	0.096
% High	37.5	29.7	0.275

[a] Patients in intervention group are unique patients, whereas patients in comparison group may include multiple visits by the same patient.
[b] Using Z-test of proportions for all except t-test for Inpatient visits, Outpatient visits, and Age (continuous).

APPENDIX A (continued)

TABLE XXXIV. SUB-ANALYSIS SAMPLE: ADJUSTED DIFFERENCES BETWEEN THE INTERVENTION AND COMPARISON GROUPS BEFORE AND 6 MONTHS POST EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM[a, b]

VARIABLES	Inpatient Visits	ED Visits	Outpatient Visits
Treat	-0.0369	-2.370***	1.881
	(0.274)	(0.500)	(1.091)
Post1	-0.433**	-3.994***	-0.738
	(0.187)	(0.341)	(0.743)
Treat x Post1 (DID Estimate)	-0.0115	3.198***	-0.151
	(0.375)	(0.685)	(1.494)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses.
[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), patient is homeless (Y/N), patient has sickle cell disease (Y/N), poverty level of census tract (low, medium, high).

TABLE XXXV. SUB-ANALYSIS SAMPLE: ADJUSTED DIFFERENCES BETWEEN THE INTERVENTION AND COMPARISON GROUPS BEFORE AND 10 MONTHS POST EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM[a, b]

VARIABLES	Inpatient Visits	ED Visits	Outpatient Visits
Treat	-0.0499	-2.524***	2.186
	(0.333)	(0.669)	(1.357)
Post2	0.195	-2.610***	2.494***
	(0.227)	(0.456)	(0.925)
Treat x Post2 (DID Estimate)	-0.0840	3.813***	0.265
	(0.456)	(0.917)	(1.859)

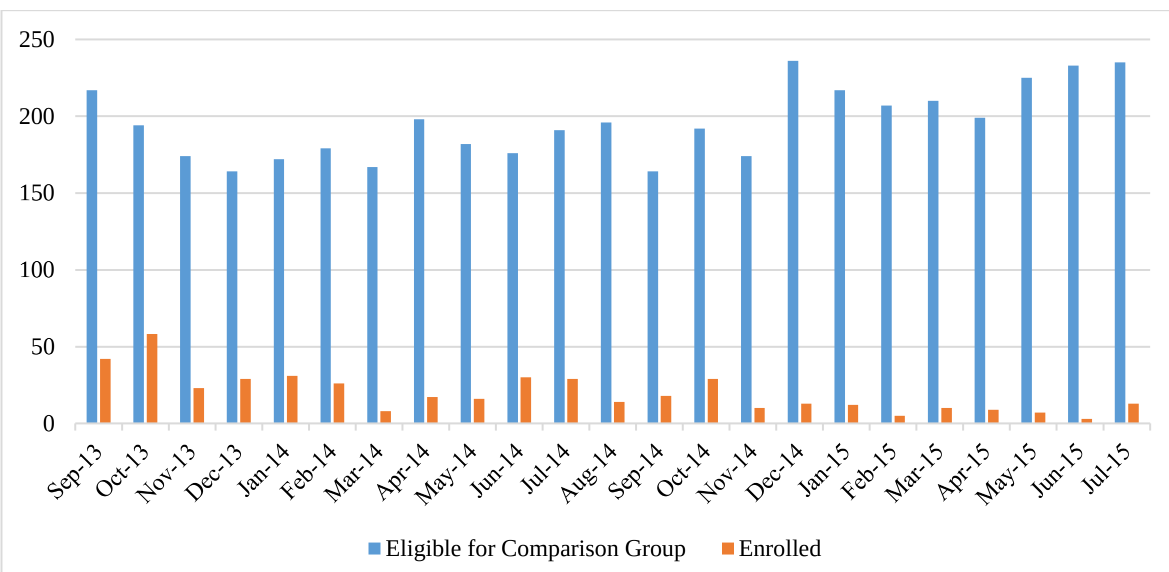
*** p<0.01, ** p<0.05
[a] Standard errors in parentheses.
[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), patient is homeless (Y/N), patient has sickle cell disease (Y/N), poverty level of census tract (low, medium, high).

APPENDIX A (continued)

Given that there were several significant differences between observable characteristics in the intervention and comparison groups of the sub-analysis, using the results from the groups that were propensity score matched in the main analysis provide a less biased estimate. It is notable that the findings go in the same direction for the main analysis and sub-analysis, however the estimates are likely overestimated in the sub-analysis.

<u>Total Number of Patients Enrolled in EPIC Program and Number of Patients in Comparison Group by Month</u>

Figure 18. Emergency Patient Interdisciplinary Care (EPIC) Total Number of Patients Enrolled in Study (N=452) and Total Number of Patients in Comparison Group (Eligible but Not Enrolled) (N=4502) by Month (September 2013-July 2015)



APPENDIX A (continued)

Sub-Analysis of Alternative Propensity Score Matching Variables

Austin (2011) suggests that despite the lack of agreement on which variables to include, the possible variable sets are: "all measured baseline covariates, all baseline covariates that are associated with treatment assignment, all covariates that affect the outcome (i.e., the potential confounders), and all covariates that affect both treatment assignment and the outcome (i.e., the true confounders). (Austin, 2011) For the main analysis of this study, we have chosen to include all observable covariates that are believed to be related to the outcome. Additionally, a sensitivity analysis was conducting using only the covariates which also affected treatment assignment. Although there were no specifications in which patients the EPIC team approached for EPIC enrollment other than the eligibility criteria of adults with 4 or more ED visits in the past year, there may have been certain patient characteristics that were related to enrollment.

In order to determine which variables were related to treatment assignment, we compared patients who arrived at the ED during weekday business hours (9am-5pm), when EPIC was recruiting, who were recruited for EPIC compared to those who arrived during the same hours but were never approached for EPIC. As shown in Table XXXVI, this analysis showed that there were several observable patient characteristics that were significantly different between these two groups. These characteristics were: African American race, other race, Hispanic, age, gender, Medicaid insurance, private insurance, Medicare insurance, all tertiles of ED visits 6 months pre-program (low, medium, high), outpatient visits 6 months pre-program, homelessness, and having sickle cell disease.

APPENDIX A (continued)

TABLE XXXVI. PATIENTS WHO ARRIVED TO THE ED DURING 9AM TO 5PM ON WEEKDAYS- COMPARISON OF THOSE WHO WERE ENROLLED IN THE EPIC PROGRAM VERSUS PATIENTS WHO WERE NOT ENROLLED IN THE EPIC PROGRAM

Patient Characteristics	Patients Enrolled in EPIC, N=348	Patients Not Enrolled in EPIC[a], N= 1839	p-value[b]
Race			
% African American	74.9	67.0	**0.004**
% White	7.3	7.7	0.804
% Other	17.8	25.3	**0.003**
Ethnicity			
% Hispanic	15.4	21.6	**0.010**
Age, Mean (SD)	45.7 (15.3)	49.1 (17.9)	**0.001**
Gender			
% Female	60.6	66.7	**0.030**
Insurance Type			
% Medicaid	48.3	42.4	**0.043**
% Private	7.8	11.3	**0.050**
% Uninsured	12.4	9.4	0.091
% Medicare	27.9	35.2	**0.008**
% Other	0.9	1.5	0.373
Tertiles of ED Visits 6 Months Pre-Program			
% Low (0-4 visits)	69.5	35.3	**0.000**
% Medium (5-7 visits)	16.1	44.3	**0.000**
% High (8+ visits)	14.4	20.4	**0.009**
Inpatient Visits 6 Months Pre-Program, Mean (SD)	1.7 (2.4)	1.5 (1.9)	0.186
Outpatient Visits 6 Months Pre-Program, Mean (SD)	5.2 (6.4)	6.9 (6.9)	**0.000**
% Homeless	13.8	4.0	**0.000**
% Sickle Cell Disease	17.0	11.9	**0.009**
Tertiles of Poverty Level for Patient's Census Tract			
% Low	35.2	35.8	0.831
% Medium	33.9	34.0	0.992
% High	30.9	30.2	0.816

[a] For comparison patients eligible for comparison group in multiple months, demographic information is that from all months of eligibility where patients arrived to the ED from 9am-5pm on Weekdays (patients may be counted more than once).
[b] Using Z-test of proportions for all except t-test for Inpatient Visits 6 Months Pre-Program, Outpatient Visits 6 Months Pre-Program, and Age (continuous)

APPENDIX A (continued)

After matching on the variables that were different between the patients enrolled in EPIC and those not approached for EPIC, Table XXXVII shows the composition of the intervention and comparison patients. While the resulting matched pairs were similar on most observable patient characteristics of interest, there were two variables that were significantly different between the two groups. First, the number of inpatient visits 6 months pre-program was higher for intervention patients than comparison patients. This variable was not used for matching because there was no significant difference between the intervention and comparison groups when limiting the sample to visits to the ED during EPIC recruitment (weekday business hours). Additionally, there was a higher proportion of comparison group patients in the high ED visit group in the pre-program period, compared to the intervention group.

Tables XXXVIII and XXXIX show the findings from the DID analysis of the matched pairs. The same ED visit outcomes were significant and in the same direction (higher for intervention than comparison group) for the DID models run with all covariates in the main analysis. The magnitude of the findings were similar for analysis with both sets of matching variables, but the magnitude of ED visits for the medium intensity group for the 10 month post-period was lower in the sub-analysis compared to the main analysis (3.0 versus 4.1, respectively). Also, the trends across intervention intensity group remained, for the most part, where the greater intensity groups had higher positive changes in ED visits for the intervention group compared to the comparison group after the program. Similar to the main analysis, the high intensity group did not have a significant DID estimate for ED visits for either post-program time period. Overall, the findings of this sensitivity analysis were consistent with the findings of

APPENDIX A (continued)

TABLE XXXVII. EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM PARTICIPANTS AND COMPARISON PATIENTS AFTER PROPENSITY SCORE MATCHING USING NEAREST NEIGHBOR 1:1 MATCHING WITH NO REPLACEMENT- USING MATCHING VARIABLES THAT WERE SIGNIFICANTLY DIFFERENT IN INTERVENTION AND COMPARISON PATIENTS WHO ARRIVED AT UNIVERSITY OF ILLINOIS HOSPITAL EMERGENCY DEPARTMENT DURING WEEKDAY BUSINESS HOURS

Patient Characteristics	Patients with Intervention, N=313	Comparison Patients, N= 313	p-value[a]
Race			
% African American[b]	78.0	80.8	0.374
% White	7.3	6.1	0.523
% Other[b]	14.7	13.1	0.564
Ethnicity			
% Hispanic[b]	12.5	11.8	0.807
Age[b], Mean (SD)	46.7 (16.2)	47.3 (17.3)	0.687
Gender			
% Female[b]	60.7	65.5	0.214
Insurance Type			
% Medicaid[b]	47.6	46.0	0.689
% Private[b]	10.2	8.9	0.587
% Uninsured	10.5	12.5	0.452
% Medicare[b]	27.8	31.0	0.380
% Other	1.0	1.6	0.477
Tertiles of ED Visits 6 Months Pre-Program			
% Low (0-4 visits)[b]	65.8	60.7	0.185
% Medium (5-7 visits)[b]	19.8	18.5	0.685
% High (8+ visits)[b]	14.4	20.8	**0.036**
Inpatient Visits 6 Months Pre-Program, Mean (SD)	1.7 (2.1)	1.3 (1.7)	**0.013**
Outpatient Visits 6 Months Pre-Program, Mean (SD)[b]	5.2 (6.0)	5.7 (6.2)	0.301
% Homeless[b]	9.3	10.9	0.507
% Sickle Cell Disease[b]	16.0	17.6	0.593
Tertiles of Poverty Level for Patient's Census Tract			
% Low	30.9	32.0	0.785
% Medium	33.2	29.9	0.383
% High	35.9	38.1	0.563

[a]Using Z-test of proportions for all except t-test for Inpatient visits, Outpatient visits, and Age (continuous)
[b]Variable was used in propensity score matching.

APPENDIX A (continued)

TABLE XXXVIII. ADJUSTED DIFFERENCES IN INPATIENT, OUTPATIENT, AND EMERGENCY DEPARTMENT VISITS BETWEEN THE INTERVENTION AND COMPARISON GROUPS BEFORE AND 6 MONTHS AFTER THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM FOR ALL PARTICIPANTS AND BY INTERVENTION INTENSITY GROUP USING ONLY MATCHING COVARIATES OF INTEREST RELATED TO INTERVENTION ENROLLMENT[a, b, c, d]

VARIABLES	All Participants N= 626	Only EPIC Note N= 182	Low Intensity N= 146	Medium Intensity N= 134	Medium-High Intensity N= 100	High Intensity N= 64
INPATIENT VISITS						
B1 (Treat)	0.404***	0.284	0.387	0.171	0.355	1.495***
	(0.141)	(0.240)	(0.292)	(0.307)	(0.423)	(0.482)
B2 (Post2)	-0.389***	-0.257	-0.503	-0.450	-0.548	0.0140
	(0.142)	(0.234)	(0.293)	(0.302)	(0.412)	(0.472)
B3 (Treat x Post2 (DID Estimate))	-0.0500	-0.0823	-0.0716	0.476	-0.246	-0.807
	(0.199)	(0.334)	(0.406)	(0.425)	(0.579)	(0.645)
EMERGENCY DEPARTMENT VISITS						
B1 (Treat)	-1.471***	-1.566***	-1.730***	-1.572**	-1.691	0.0529
	(0.319)	(0.360)	(0.560)	(0.626)	(1.171)	(1.620)
B2 (Post2)	-3.515***	-3.237***	-3.401***	-4.018***	-3.419***	-3.441**
	(0.320)	(0.352)	(0.562)	(0.617)	(1.141)	(1.586)
B3 (Treat x Post2 (DID Estimate))	2.491***	2.236***	2.083***	2.402***	3.946**	2.287
	(0.449)	(0.502)	(0.779)	(0.867)	(1.601)	(2.167)
OUTPATIENT VISITS						
B1 (Treat)	-0.494	0.853	-0.544	-0.799	-2.652***	0.248
	(0.456)	(0.932)	(0.939)	(0.865)	(1.001)	(1.771)
B2 (Post2)	-0.844	-0.460	-0.0882	-0.835	-1.955**	-2.084
	(0.458)	(0.910)	(0.943)	(0.854)	(0.975)	(1.735)
B3 (Treat x Post2 (DID Estimate))	0.113	-0.716	0.615	-0.840	1.686	0.748
	(0.642)	(1.298)	(1.307)	(1.199)	(1.369)	(2.370)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), patient is homeless (Y/N), patient has sickle cell disease (Y/N), and study duration (days).

[c] Using 1:1 nearest neighbor matching without replacement.

[d] N is the total number of EPIC intervention and comparison patients.

APPENDIX A (continued)

TABLE XXXIX. ADJUSTED DIFFERENCES IN INPATIENT, OUTPATIENT, AND EMERGENCY DEPARTMENT VISITS BETWEEN THE INTERVENTION AND COMPARISON GROUPS BEFORE AND 10 MONTHS AFTER THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM FOR ALL PARTICIPANTS AND BY INTERVENTION INTENSITY GROUP USING ONLY MATCHING COVARIATES OF INTEREST RELATED TO INTERVENTION ENROLLMENT[a, b, c, d]

VARIABLES	All Participants N= 626	Only EPIC Note N= 182	Low Intensity N= 146	Medium Intensity N= 134	Medium-High Intensity N= 100	High Intensity N= 64
INPATIENT VISITS						
B1 (Treat)	0.414**	0.293	0.380	0.176	0.306	1.566**
	(0.186)	(0.295)	(0.385)	(0.403)	(0.600)	(0.622)
B2 (Post2)	0.192	0.453	0.0706	0.00569	0.0580	0.492
	(0.187)	(0.288)	(0.386)	(0.398)	(0.585)	(0.610)
B3 (Treat x Post2 (DID Estimate))	0.0902	-0.392	0.230	0.750	0.375	-0.767
	(0.263)	(0.411)	(0.535)	(0.558)	(0.821)	(0.833)
EMERGENCY DEPARTMENT VISITS						
B1 (Treat)	-1.461***	-1.535***	-1.688**	-1.525**	-1.652	0.0457
	(0.370)	(0.466)	(0.680)	(0.760)	(1.333)	(1.697)
B2 (Post2)	-2.169***	-1.918***	-1.785***	-2.772***	-2.312*	-2.008
	(0.371)	(0.455)	(0.682)	(0.750)	(1.298)	(1.662)
B3 (Treat x Post2 (DID Estimate))	2.779***	2.168***	2.152**	2.992***	4.912***	2.446
	(0.520)	(0.650)	(0.946)	(1.053)	(1.822)	(2.271)
OUTPATIENT VISITS						
B1 (Treat)	-0.456	0.810	-0.506	-0.746	-2.414	0.154
	(0.594)	(1.216)	(1.264)	(1.050)	(1.259)	(2.423)
B2 (Post2)	2.227***	2.995**	3.003**	1.465	1.211	1.039
	(0.597)	(1.187)	(1.269)	(1.036)	(1.227)	(2.373)
B3 (Treat x Post2 (DID Estimate))	-0.453	-0.591	-0.312	-1.138	0.00257	0.788
	(0.836)	(1.694)	(1.759)	(1.454)	(1.722)	(3.241)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), patient is homeless (Y/N), patient has sickle cell disease (Y/N), and study duration (days).

[c] Using 1:1 nearest neighbor matching without replacement.

[d] N is the total number of EPIC intervention and comparison patients.

APPENDIX A (continued)

our main analysis, suggesting that the propensity score matching variables used did not play a role in our findings.

Sensitivity Analysis Using Matching with Replacement

In the main analysis, we used propensity score matching with 1:1 nearest neighbor with no replacement. In order to test the sensitivity of our findings, we also used propensity score matching with replacement. Similar to the 1:1 matching with no replacement, some matches (N=35) were dropped because there were no visits (ED, inpatient, or outpatient) for the matched comparison group patient in the 10 months post-program period. Matching with replacement allows for one patient in the comparison group to be used as a comparison to multiple patients in the intervention group within the same month of enrollment/eligibility. In our matching, there were 27 patients that were used as a comparison match for two intervention patients, 9 that were matched to three intervention patients, 1 that was matched to 4 intervention patients, 3 that were matched to 5 intervention patients, and 1 comparison patient that was used as a comparison match for 7 intervention patients. As seen in Table XL, there were no significant differences in observable variables in the two groups after matching.

APPENDIX A (continued)

TABLE XL. EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM PARTICIPANTS AND COMPARISON PATIENTS AFTER PROPENSITY SCORE MATCHING USING NEAREST NEIGHBOR MATCHING WITH REPLACEMENT

Patient Characteristics	Patients with Intervention, N= 291	Comparison Patients, N= 231	p-value[a]
Race			
% African American	78.0	73.6	0.241
% White	6.9	10.4	0.151
% Other	15.1	16.0	0.779
Ethnicity			
% Hispanic	14.1	12.6	0.609
Age, Mean (Standard Deviation)	46.5 (15.9)	45.8 (16.8)	0.610
Gender			
% Female	63.6	63.6	0.988
Insurance Type			
% Medicaid	50.2	52.4	0.616
% Private	10.7	12.1	0.599
% Uninsured	10.7	9.1	0.554
% Medicare	28.2	26.4	0.652
% Other	0.3	0.0	0.373
ED Visits 6 Months Pre-Program			
% Low (0-4 visits)	66.3	66.7	0.934
% Medium (5-7 visits)	20.3	20.3	0.984
% High (8+ visits)	13.4	13.0	0.889
Inpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	1.8 (2.2)	1.5 (1.8)	0.088
Outpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	5.6 (6.1)	5.3 (6.1)	0.483
% Homeless	8.2	6.5	0.449
% Sickle Cell Disease	18.2	16.9	0.692
Poverty Rate in Patient’s Census Tract			
% Low	30.6	32.9	0.572
% Medium	33.3	32.5	0.834
% High	36.1	34.6	0.731

[a]Using Z-test of proportions for all except t-test for continuous variables of Inpatient Visits 6 Months Pre-Program, Outpatient Visits 6 Months Pre-Program, and Age

APPENDIX A (continued)

Tables XLI and XLII show the findings from the DID analysis of these groups. The same ED visit outcomes were significant and in the same direction (higher for intervention than comparison group) for the DID models run with the matched groups with and without replacement. The magnitude of the findings were slightly higher for the main analysis that used matching without replacement. Also, the trends across intervention intensity group remained for the most part, where the greater intensity groups had higher positive changes in ED visits for the intervention group compared to the comparison group after the program. The matching with replacement findings were somewhat less linear, where the low intensity group magnitude was lower than that of the lowest intensity group for the 6 month post-period. Similarly, the magnitude of the point estimate for the medium-high intensity group was less than the magnitude of the point estimate for the medium intensity group for the no replacement matching groups. Overall, the findings of this sensitivity analysis are consistent with the findings of our main analysis, suggesting that the type of propensity score matching used does not play a role in our findings.

APPENDIX A (continued)

TABLE XLI. ADJUSTED DIFFERENCES IN INPATIENT, OUTPATIENT, AND EMERGENCY DEPARTMENT VISITS BETWEEN THE INTERVENTION AND COMPARISON GROUPS BEFORE AND 6 MONTHS AFTER THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM FOR ALL PARTICIPANTS AND BY INTERVENTION INTENSITY GROUP[a, b, c, d]

VARIABLES	All Participants N=582	Only EPIC Note N=182	Low Intensity N=136	Medium Intensity N=128	Medium-High Intensity N=86	High Intensity N=50
INPATIENT VISITS						
Treat	0.285	-0.137	0.0978	0.598	0.897	0.705
	(0.150)	(0.234)	(0.298)	(0.314)	(0.471)	(0.621)
Post1	-0.555***	-0.524**	-0.796***	-0.157	-0.674	-0.834
	(0.153)	(0.237)	(0.301)	(0.308)	(0.458)	(0.594)
Treat x Post1 (DID Estimate)	0.113	0.102	0.274	0.144	0.0286	-0.0656
	(0.212)	(0.326)	(0.420)	(0.431)	(0.643)	(0.833)
EMERGENCY DEPARTMENT VISITS						
Treat	-0.950***	-1.431***	-0.725	-1.008	-1.215	0.594
	(0.298)	(0.338)	(0.483)	(0.792)	(1.073)	(1.456)
Post1	-3.147***	-2.953***	-2.868***	-3.502***	-3.441***	-3.198**
	(0.303)	(0.343)	(0.487)	(0.778)	(1.044)	(1.393)
Treat x Post2 (DID Estimate)	2.125***	2.006***	1.633**	2.634**	3.403**	0.765
	(0.420)	(0.471)	(0.680)	(1.089)	(1.465)	(1.951)
OUTPATIENT VISITS						
Treat	0.512	1.582	0.711	1.449	-2.247	-0.917
	(0.464)	(0.900)	(0.925)	(0.781)	(1.358)	(1.734)
Post1	-0.448	-0.171	-0.738	0.148	-0.934	-0.797
	(0.472)	(0.912)	(0.934)	(0.766)	(1.321)	(1.659)
Treat x Post1 (DID Estimate)	-0.0189	-0.561	0.813	-1.329	1.007	0.498
	(0.654)	(1.251)	(1.303)	(1.073)	(1.853)	(2.324)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), homeless (Y/N), sickle cell disease (Y/N), poverty level of census tract (low, medium, high), and study duration (days).

[c] Using nearest neighbor matching with replacement.

[d] N is the total number of EPIC intervention and comparison patients.

APPENDIX A (continued)

TABLE XLII. ADJUSTED DIFFERENCES IN INPATIENT, OUTPATIENT, AND EMERGENCY DEPARTMENT VISITS BETWEEN THE INTERVENTION AND COMPARISON GROUPS BEFORE AND 10 MONTHS AFTER THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM FOR ALL PARTICIPANTS AND BY INTERVENTION INTENSITY GROUP[a, b, c, d]

VARIABLES	All Participants N=582	Only EPIC Note N=182	Low Intensity N=136	Medium Intensity N=128	Medium-High Intensity N=86	High Intensity N=50
INPATIENT VISITS						
Treat	0.297	-0.142	0.0603	0.700	1.027	0.604
	(0.193)	(0.260)	(0.391)	(0.414)	(0.646)	(0.836)
Post2	-0.0587	-0.0805	-0.329	0.469	-0.241	-0.144
	(0.197)	(0.264)	(0.395)	(0.406)	(0.628)	(0.800)
Treat x Post2 (DID Estimate)	0.367	0.0794	0.601	0.329	1.003	-0.127
	(0.272)	(0.362)	(0.551)	(0.568)	(0.882)	(1.120)
EMERGENCY DEPARTMENT VISITS						
Treat	-0.951**	-1.424***	-0.726	-0.889	-1.381	0.0737
	(0.391)	(0.388)	(0.610)	(1.175)	(1.409)	(1.647)
Post2	-1.945***	-1.824***	-1.775***	-2.524**	-1.607	-1.950
	(0.398)	(0.394)	(0.616)	(1.154)	(1.370)	(1.576)
Treat x Post2 (DID Estimate)	2.655***	1.999***	2.137**	3.956**	3.809**	1.735
	(0.551)	(0.540)	(0.859)	(1.615)	(1.923)	(2.207)
OUTPATIENT VISITS						
Treat	0.495	1.410	0.746	1.564	-2.354	-1.426
	(0.602)	(1.169)	(1.182)	(0.992)	(1.767)	(2.478)
Post2	2.326***	2.598**	1.834	2.480**	2.307	3.144
	(0.613)	(1.186)	(1.193)	(0.974)	(1.719)	(2.371)
Treat x Post2 (DID Estimate)	0.138	0.784	0.276	-1.080	-0.205	0.00475
	(0.849)	(1.627)	(1.665)	(1.363)	(2.412)	(3.321)

*** $p<0.01$, ** $p<0.05$

[a] Standard errors in parentheses.

[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), homeless (Y/N), sickle cell disease (Y/N), poverty level of census tract (low, medium, high), and study duration (days).

[c] Using nearest neighbor matching with replacement.

[d] N is the total number of EPIC intervention and comparison patients.

APPENDIX A (continued)

EPIC Participants Included in Propensity Score Matching with Missing Values Compared to Those Without Missing Values

TABLE XLIII. EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PARTICIPANTS INCLUDED IN PROPENSITY SCORE MATCHING (N=399) WITH MISSING VALUES COMPARED TO THOSE WITHOUT MISSING VALUES

Patient Characteristics	EPIC Participants with Missing Values, N= 36	EPIC Participants without Missing Values, N= 363	p-value[a]
Race			
% African American	85.7	78.5	0.317
% White	5.7	7.2	0.749
% Other	8.6	14.3	0.346
Ethnicity			
% Hispanic	0.0	12.9	0.150
Age, Mean (Standard Deviation)	43.4 (14.6)	46.7 (16.3)	0.233
Gender			
% Female	63.9	61.2	0.748
Insurance Type			
% Medicaid	36.1	48.5	0.156
% Private	2.8	9.6	0.170
% Uninsured	22.2	10.5	**0.035**
% Medicare	30.6	27.8	0.728
% Other	2.8	0.8	0.262
ED Visits 6 Months Pre-Program, Mean (Standard Deviation)	4.3 (3.6)	4.3 (4.5)	0.990
Inpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	1.6 (1.9)	1.8 (2.3)	0.670
Outpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	5.6 (5.6)	5.6 (6.7)	0.993
% Homeless	19.4	11.0	0.135
% Sickle Cell Disease	25.0	18.2	0.318
Poverty Rate in Patient's Census Tract			
% Low	18.2	31.1	0.200
% Medium	50.0	33.9	0.123
% High	31.8	35.0	0.762

[a]Using Z-test of proportions for all except t-test for continuous variables of ED Visits 6 Months Pre-Program, Inpatient Visits 6 Months Pre-Program, Outpatient Visits 6 Months Pre-Program, and Age.

APPENDIX A (continued)

<u>Demographic Characteristics for EPIC Participants Used in Main Analysis by Intervention Intensity Group</u>

TABLE XLIV. DEMOGRAPHIC CHARACTERISTICS FOR EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PARTICIPANTS USED IN MAIN DIFFERENCE-IN-DIFFERENCES ANALYSIS (N=306) BY INTERVENTION INTENSITY GROUP

	Intervention Intensity Group				
Participant Characteristics	No EPIC Note (N=90)	Low (N=72)	Medium (N=69)	Medium-High (N=45)	High (N=30)
Race					
% African American	74.4	75.0	76.8	93.3	83.3
% White	7.8	8.3	4.3	2.2	10.0
% Other	17.8	16.7	18.8	4.4	6.7
Ethnicity					
% Hispanic	16.7	13.9	17.4	4.4	10.0
Age, Mean (Standard Deviation)	51.2 (16.2)	45.7 (16.5)	44.1 (15.6)	45.3 (13.7)	50.1 (16.5)
Gender					
% Female	65.6	56.7	63.8	62.2	63.3
Insurance Type					
% Medicaid	43.3	48.6	53.6	57.8	46.7
% Private	14.4	15.3	4.3	8.9	0.0
% Uninsured	2.2	15.3	13.0	17.8	10.0
% Medicare	38.9	20.8	24.6	15.6	43.3
% Other	1.1	0.0	0.0	0.0	0.0
ED Visits 6 Months Pre-Program, Mean (Standard Deviation)	3.3 (2.2)	4.3 (3.3)	4.3 (4.7)	4.9 (5.1)	6.1 (7.2)
Inpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	1.5 (1.7)	1.6 (2.0)	1.6 (1.9)	2.1 (3.0)	2.0 (2.5)
Outpatient Visits 6 Months Pre-Program, Mean (Standard Deviation)	7.8 (7.1)	5.2 (5.8)	4.6 (5.0)	3.9 (4.4)	4.8 (6.4)
% Homeless	3.3	8.3	11.6	13.3	13.3
% Sickle Cell Disease	15.6	16.7	15.9	13.3	20.0
Poverty Rate in Patient's Census Tract					
% Low	33.3	34.7	24.6	17.8	36.7
% Medium	33.3	33.3	39.1	42.2	23.3
% High	33.3	31.9	36.2	40.0	40.0

APPENDIX A (continued)

<u>Sub-Analysis of Outcomes for EPIC Intervention Group Before and After EPIC Program-Without Comparison Group</u>

We wanted to determine if there was a significant change in number of inpatient, ED, and outpatient visits for patients in the EPIC program after the program, without a comparison group. In the main analysis, we found that the number of ED visits was significantly higher for patients in the EPIC intervention group than patients in the comparison group, comparing before and after the program period. We wanted to see if there would have been a decrease in ED visits, or other significant visit findings, if we had not included a comparison group in our analysis. To explore this, we ran the following model:

$$(3)\quad Y_t^j = \beta_0 + \beta_1 Post_t + \beta_2' X_t + \varepsilon_t$$

In Equation (3), Y_t were the outcomes, where each j was one of three different outcome variables- number of ED visits, outpatient visits, and inpatient visits during the time frame of interest (6 months post-program and 10 months post-program). There were two different $Post_t$ periods. One $Post_t$ was a time variable where 0 was the six months pre-program and 1 was 6 months post-program. The second $Post_t$ was a time variable where 0 was the six months pre-program and 1 was 10 months post-program. The coefficient of interest was β_1, which was the change in visits between the pre-EPIC and post-EPIC periods. X was the covariates that were controlled- race (white, black, other), ethnicity (Hispanic, Non-Hispanic), age, sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), homelessness (yes, no), patient has sickle cell disease (yes, no), poverty in patient's census tract duration (low, medium, and high tertiles). ε_t was the error term. Two observations were used for each individual for each model- one in the pre-period and one in the post-period. Covariates for the pre-period observation were those from the enrollment visit (in the case of the EPIC intervention group) or from the first ED visit in the eligibility month (in the case of the comparison group). Covariates used for the post-period observation period were those of the first ED visit during or after the last month of the intervention period.

Table XLV shows findings from the 6 month post-period and Table XLVI shows findings from the 10 month post-period. In the main analysis DID model for the 6 month post-period, there were no significant DID estimates for inpatient or outpatient visits. For ED visits in the main analysis, all DID estimates were significant and positive except for patients in the high intensity group. This meant that patients in the intervention group had more ED visits than patients in the comparison group, comparing the pre-EPIC period to the post-EPIC period. In Table XLV, where there was no comparison group, there was a significant negative difference in ED visits comparing the pre-EPIC period to the post-EPIC period for patients with only an EPIC note (-0.9 visits) and those in the low intensity group (-1.4 visits). There was no significant difference in ED visits for the intervention group overall or for any other intensity group. This decrease in ED visits was in the opposite direction of the increase in ED visits from the main analysis. This finding shows that the results without a comparison group would have shown a decrease in ED visits from the program. Additionally, the sub-analysis without a comparison group showed that overall, intervention patients had a significant decrease in inpatient visits (-0.4 visits) after the EPIC program period, which was not found in our main analysis.

In the 10 month post-period main analysis, there were no significant DID estimates for inpatient or outpatient visits. In the main analysis, there was a significant increase in ED visits for the intervention group overall compared to the comparison group in the post-EPIC period compared to the pre-EPIC period (2.9 visits). There were also significant increases in ED visits (ranging from 1.6 to 4.6 visits) for all intensity groups except for the high intensity group. In Table XLVI, the sub-analysis of the intervention group without a comparison group had a significant increase of 1.1 ED visits in the post-period compared to the pre-EPIC period for the intervention group as a whole. This value follows the direction (positive) of the main analysis findings, although the magnitude is smaller. Where almost all intervention intensity groups in the main analysis had significantly positive increases in ED visits, the individual intensity groups had fewer significant ED visit change in the sub-analysis. In the sub-analysis, there were also significant findings that were not present in the DID estimate of the intervention and comparison groups. There were significant positive increases in outpatient visits after EPIC for the overall intervention group (2.4 visits) and those patients with only an EPIC note (3.9 visits). There was also a significant positive increase in inpatient visits (1.0 visits) for the medium intensity group after the EPIC program.

This sub-analysis showed that without a comparison group there would have been differences in findings for the effect of the EPIC program on its participants. There would have been significant findings for change in inpatient and outpatient visits, which we did not find in the main analysis. There also was a decrease in ED visits for the 6 month post-EPIC period, for which we found increased when comparing the intervention group to the comparison group. While the change in ED visits in the 10 month post-period was in the same direction as our DID model with the comparison group, the magnitude was smaller without the comparison group and there were no significant findings for any individual intervention intensity groups.

APPENDIX A (continued)

TABLE XLV. ADJUSTED DIFFERENCES IN INPATIENT, OUTPATIENT, AND EMERGENCY DEPARTMENT VISITS FOR THE INTERVENTION GROUP BEFORE AND 6 MONTHS AFTER THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM FOR ALL PARTICIPANTS AND BY INTERVENTION INTENSITY GROUP[a, b]

VARIABLES	All Participants N=306	Only EPIC Note N=90	Low Intensity N=72	Medium Intensity N=69	Medium-High Intensity N=45	High Intensity N=30
INPATIENT VISITS						
Post-EPIC	-0.356**	-0.312	-0.537	0.120	-0.804	-0.660
	(0.163)	(0.235)	(0.297)	(0.360)	(0.524)	(0.603)
EMERGENCY DEPARTMENT VISITS						
Post-EPIC	-0.630	-0.859**	-1.425***	-0.408	0.930	-0.690
	(0.409)	(0.338)	(0.515)	(0.941)	(1.709)	(2.338)
OUTPATIENT VISITS						
Post-EPIC	-0.474	-0.459	0.0844	-0.974	-0.320	0.00337
	(0.476)	(0.982)	(0.929)	(0.773)	(1.004)	(1.653)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), patient is homeless (Y/N), patient has sickle cell disease (Y/N), poverty level of census tract (low, medium, high), and study duration (days).

APPENDIX A (continued)

TABLE XLVI. ADJUSTED DIFFERENCES IN INPATIENT, OUTPATIENT, AND EMERGENCY DEPARTMENT VISITS FOR THE INTERVENTION GROUP BEFORE AND 10 MONTHS AFTER THE EMERGENCY PATIENT INTERDISCIPLINARY CARE (EPIC) PROGRAM FOR ALL PARTICIPANTS AND BY INTERVENTION INTENSITY GROUP[a, b]

VARIABLES	All Participants N=306	Only EPIC Note N=90	Low Intensity N=72	Medium Intensity N=69	Medium-High Intensity N=45	High Intensity N=30
INPATIENT VISITS						
Post-EPIC	0.340	0.143	0.137	1.002**	0.321	-0.169
	(0.211)	(0.267)	(0.367)	(0.492)	(0.727)	(0.827)
EMERGENCY DEPARTMENT VISITS						
Post-EPIC	1.100**	0.299	0.0667	2.241	2.807	1.177
	(0.509)	(0.394)	(0.655)	(1.449)	(1.890)	(2.488)
OUTPATIENT VISITS						
Post-EPIC	2.367***	3.850***	2.091	1.621	1.429	2.556
	(0.613)	(1.312)	(1.154)	(0.978)	(1.312)	(2.137)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses.

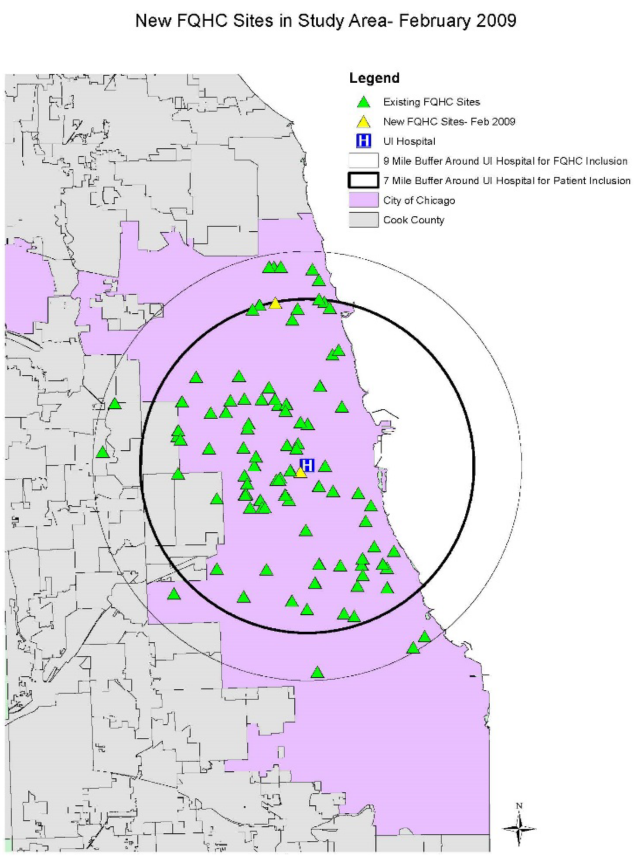
[b] Adjusted for age (continuous), sex (male, female), insurance type (Medicaid, private, uninsured, Medicare, other), race (black, white, other), ethnicity (Hispanic, non-Hispanic), patient is homeless (Y/N), patient has sickle cell disease (Y/N), poverty level of census tract (low, medium, high), and study duration (days).

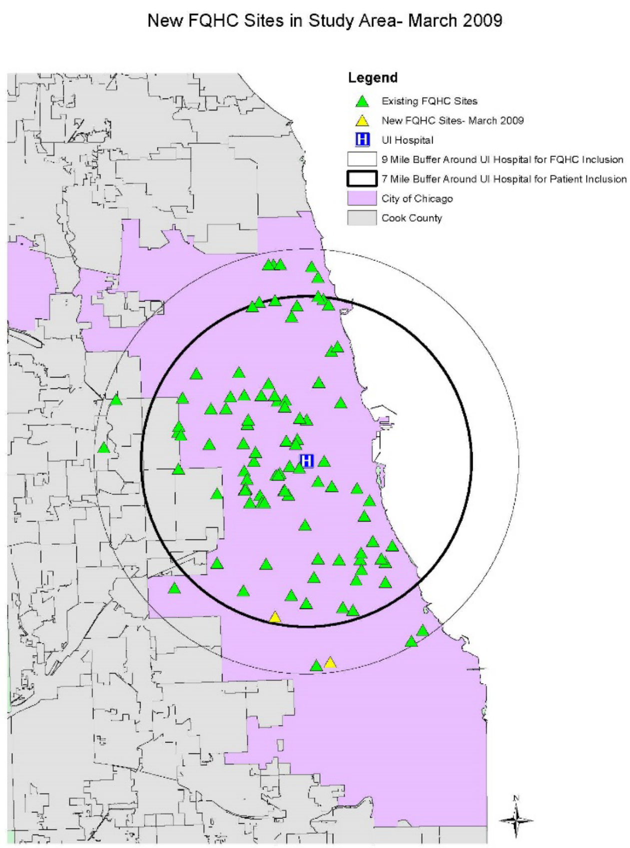
APPENDIX B

Maps of New Federally Qualified Health Centers (FQHCs) by Month for Study Time Period

Figure 19. Maps of New Federally Qualified Health Centers (FQHCs) by Month for Study Time Period (February 2009-July 2011)

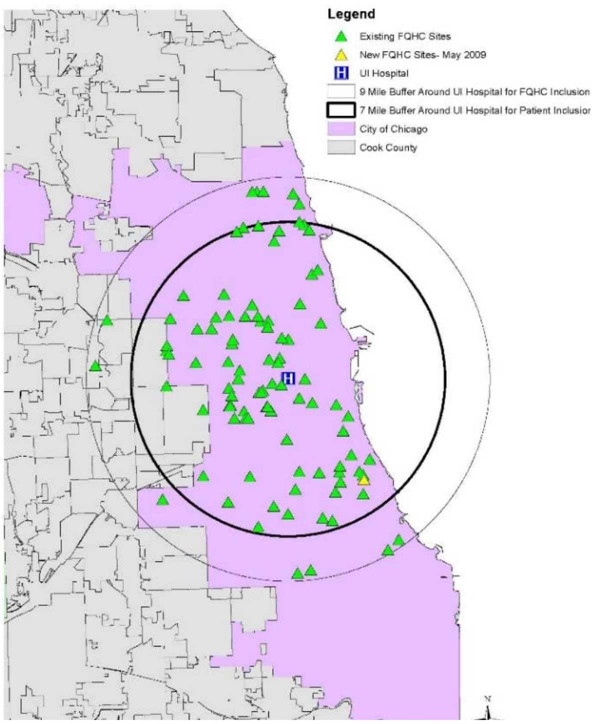
Note: There were no new FQHCs in the months of April 2009, June 2009, August 2009, September 2009, March 2010, April 2010, June 2010, September 2010, November 2010, March 2011, April 2011, May 2011, or June 2011.



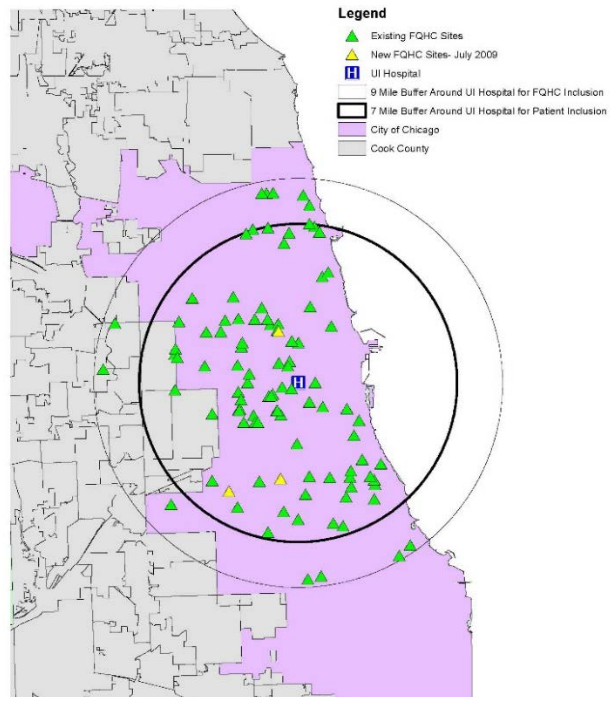


APPENDIX B (continued), **Figure 19** (continued)

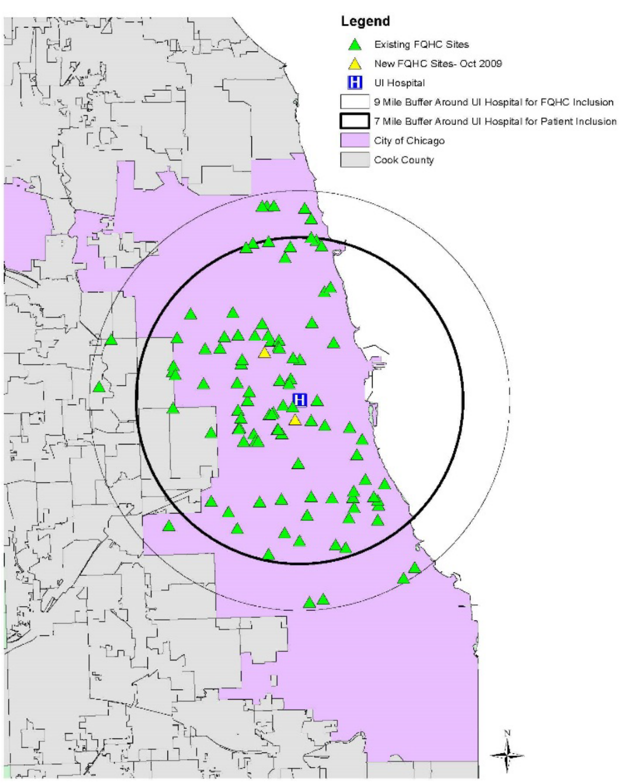
New FQHC Sites in Study Area- May 2009



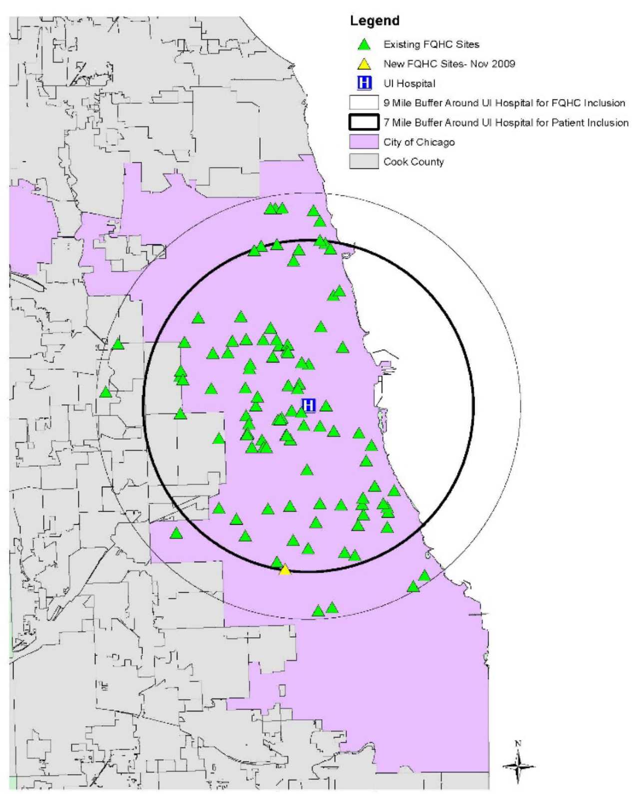
New FQHC Sites in Study Area- July 2009



New FQHC Sites in Study Area- October 2009

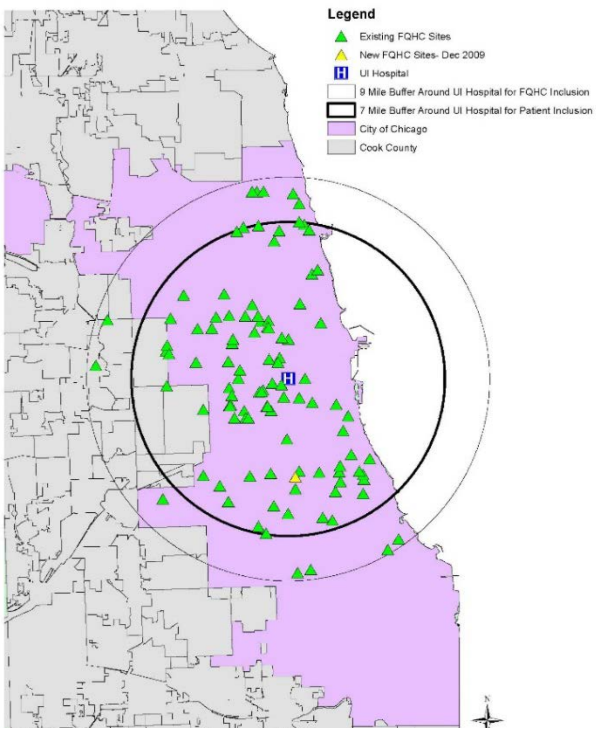


New FQHC Sites in Study Area- November 2009

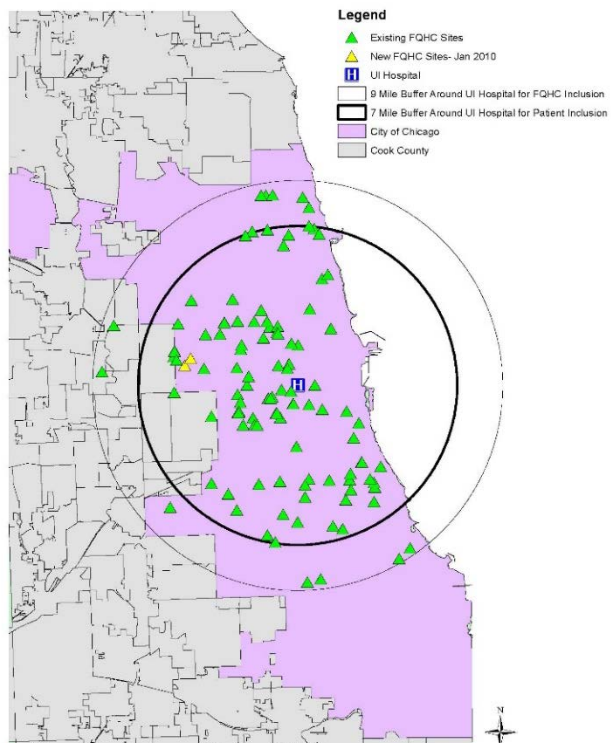


APPENDIX B (continued), **Figure 19** (continued)

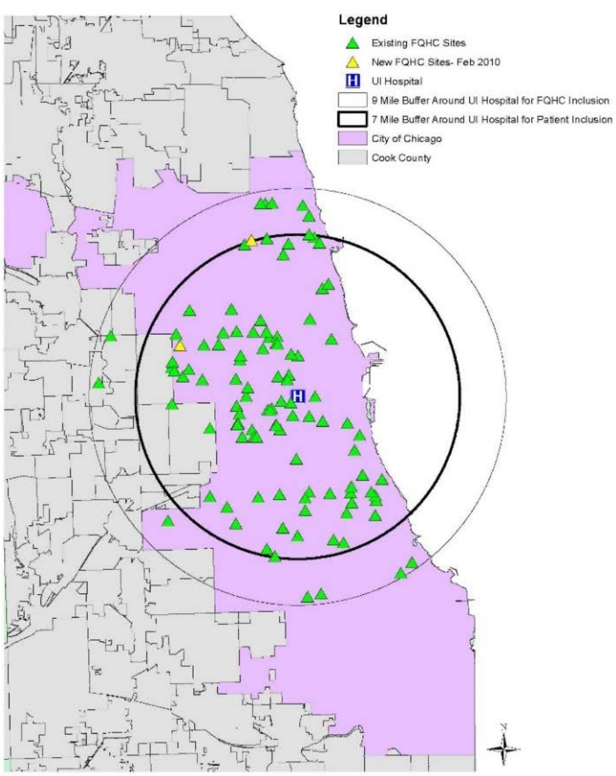
New FQHC Sites in Study Area- December 2009



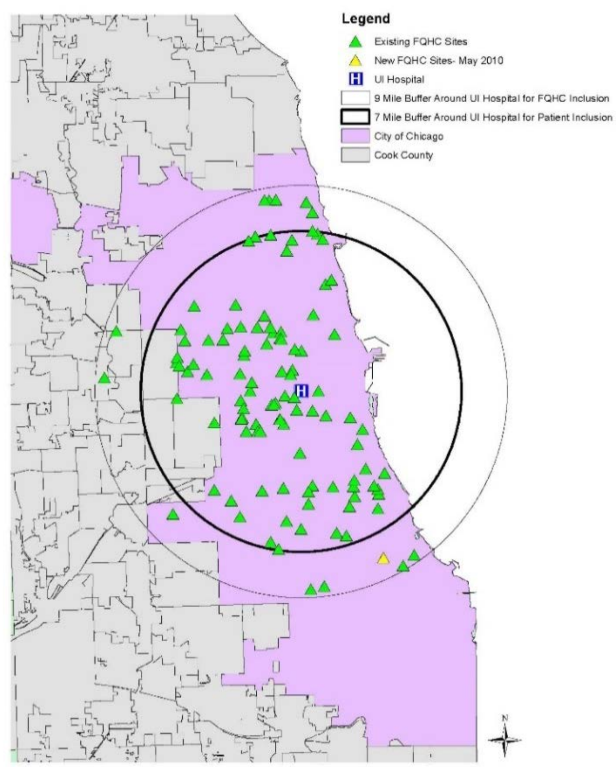
New FQHC Sites in Study Area- January 2010



New FQHC Sites in Study Area- February 2010

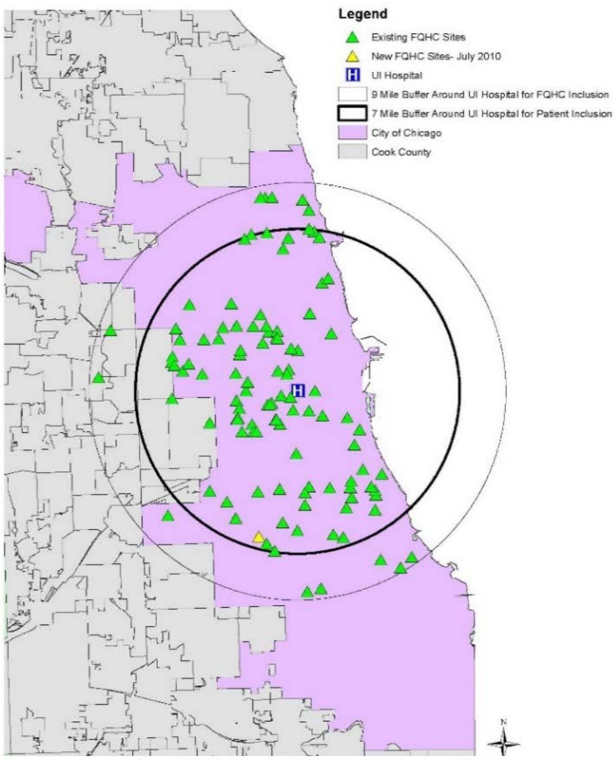


New FQHC Sites in Study Area- May 2010

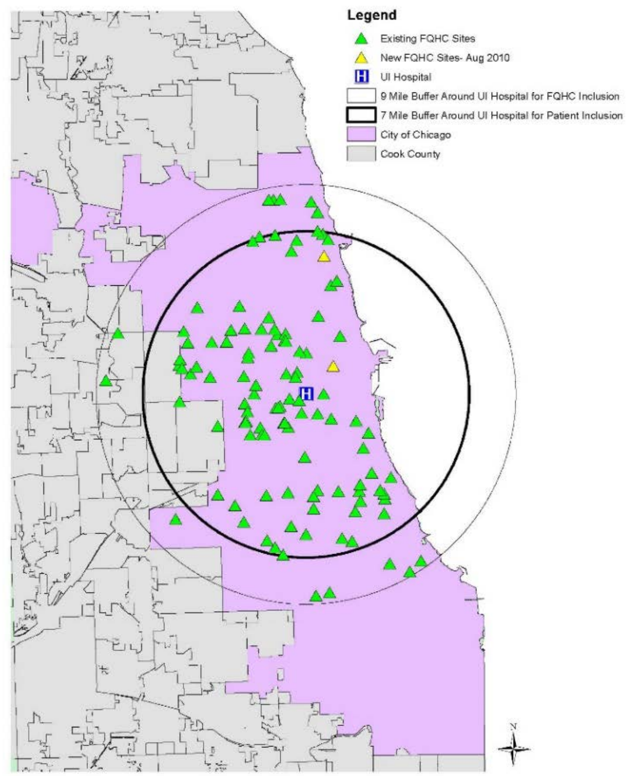


APPENDIX B (continued), **Figure 19** (continued)

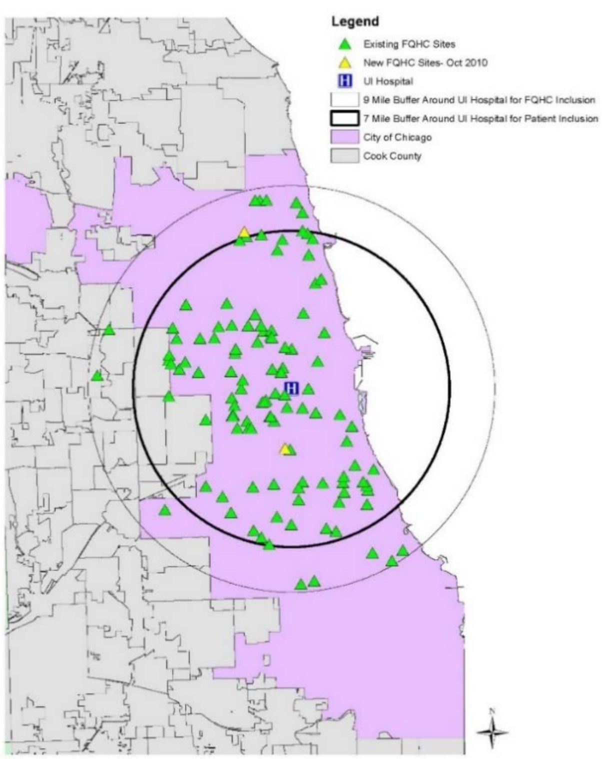
New FQHC Sites in Study Area- July 2010

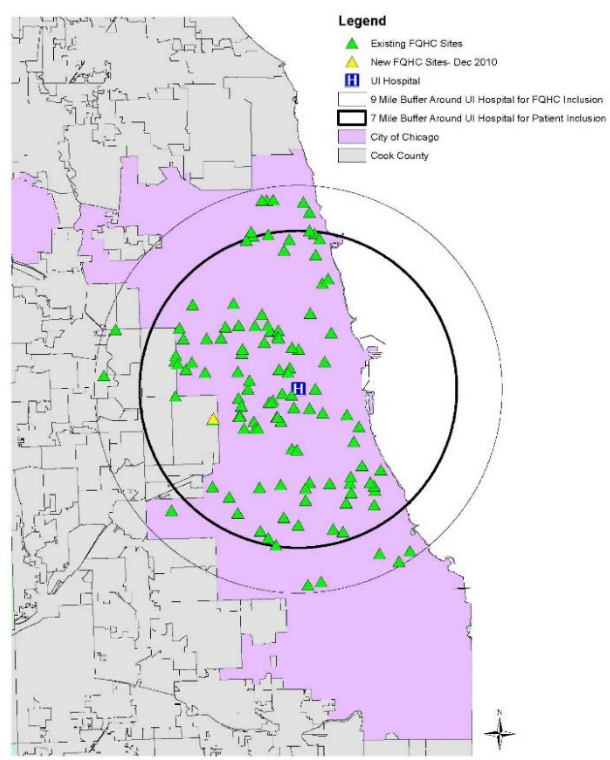


New FQHC Sites in Study Area- August 2010



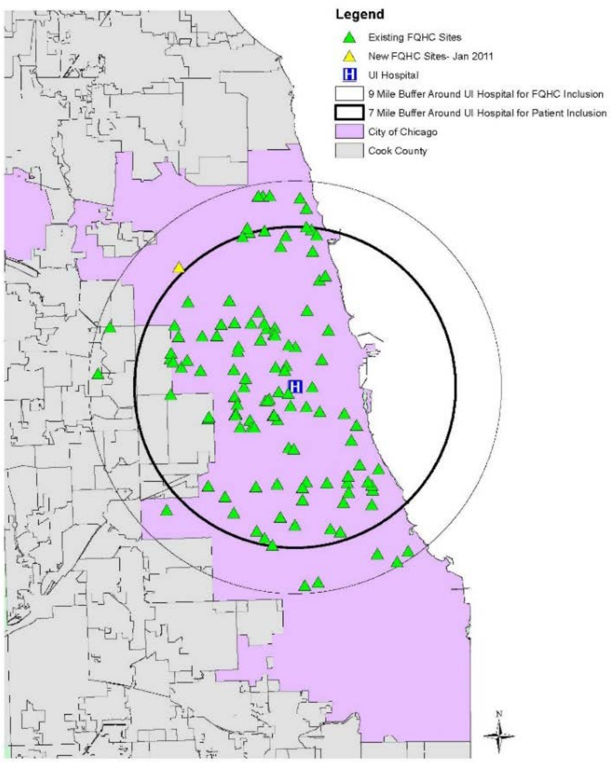
New FQHC Sites in Study Area- October 2010



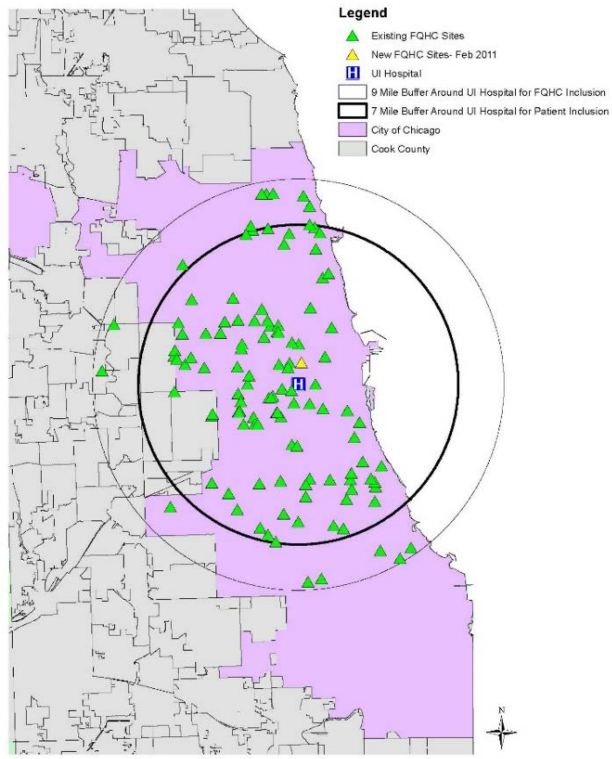


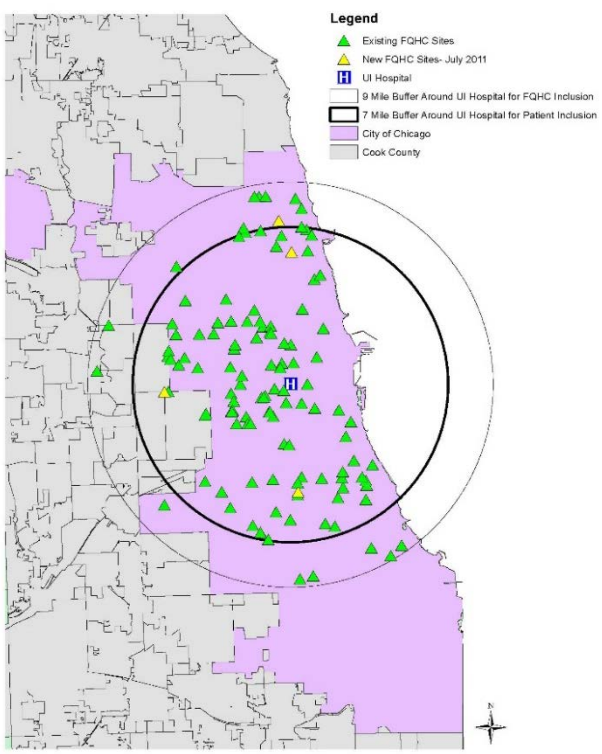
APPENDIX B (continued), **Figure 19** (continued)

New FQHC Sites in Study Area- January 2011



New FQHC Sites in Study Area- February 2011





APPENDIX B (continued)

Sub-Analysis: Stratified Analysis Based on Distance from Patient's Home to UI Hospital

A sub-analysis was completed that separated the study sample into two groups- patients who lived closer to UI Hospital and those who lived further from UI Hospital. There may have been differences in healthcare utilization at UI Hospital or at neighborhood FQHCs between the two groups because of differences in travel time to care and availability of health care options. The mean distance to hospital was 11.76 quarter miles. Patients in the "Closer to Hospital" group were those who lived less than 3 miles (12 quarter miles) from the hospital, and those in the "Further from Hospital" group were those who lived at least 3 miles (12 quarter miles) from the hospital. The models for each group were equivalent to the main analysis, where the linear regression models were run two ways- as 1) patient fixed effects models, and 2) pooled cross-sectional models, and standard errors were clustered by patient zip code.

1. **Patients who Live Closer to Hospital- Patient Fixed Effects**

Table XLVII shows the association between distance to closest FQHC and probability of having a non-urgent ED visit to UI Hospital for patients who lived less than 3 miles from UI Hospital, looking at within patient changes using patient fixed effects. There were significant findings at the 50% and 60% non-emergent (NE) thresholds. These findings suggest that, within the same patient, a one-quarter mile increase in distance to closest FQHC is associated with a 7% increase in the probability that the ED visit is at least above the 50% non-emergent threshold (NE50=1). Also, a one-quarter mile increase in distance to closest FQHC is associated with a 9% increase in the probability that the ED visit is at least above the 60% non-emergent threshold (NE60=1). These findings support the hypothesis that distance to closest FQHC and non-urgent ED utilization go in the same direction. In other words, as distance to closest FQHC decreases,

APPENDIX B (continued)

we expected non-urgent ED utilization to decrease. Since there were no significant findings for these outcomes for the study sample as a whole, it is possible that patients who live closer to the hospital are more aware of new healthcare resources than those who live further away, and perhaps UI Hospital and other nearby hospitals may better communicate these alternative health resources to patients who live nearby. They may also have more transportation options than patients who live further from the hospital, because of the central location of the hospital.

The other significant coefficients for this model were 90% and 95% PCT visits. These outcomes had negative coefficients in the linear probability model, so they were also run using logistic regression, in order to interpret the findings. The logistic model found that these outcomes had very small, but statistically significant odds ratios of 0.00126 for both outcomes. This odds ratio is difficult to interpret because it is so close to zero.

Table XLVIII shows the association between distance to closest FQHC and continuous mean probability for non-urgent visits, within patients, for patients who live closer (less than 3 miles) to the hospital. There were no significant findings for these models.

Table XLIX shows the association between distance to closest FQHC and ESI level, using a patient fixed effects model for patients who lived less than 3 miles from the hospital. The association was not significant for the ESI outcome.

APPENDIX B (continued)

TABLE XLVII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – PATIENT FIXED EFFECTS- PATIENTS LIVING LESS THAN 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=2,831 PATIENT-MONTHS)[a, b, c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	0.0746**	0.0880***	0.00803	0.0181	0.00502	-0.00724
	(0.0249)	(0.0218)	(0.0458)	(0.0170)	(0.0241)	(0.00927)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	-0.0482	-0.0282	-0.0567	-0.0627	-0.0275**	-0.0275**
	(0.0449)	(0.0444)	(0.0310)	(0.0355)	(0.00934)	(0.00934)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	-0.00180	0.00884	-0.00948	0.0117	0.0355	-0.00922
	(0.0767)	(0.0788)	(0.0468)	(0.0551)	(0.0282)	(0.0218)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

APPENDIX B (continued)

TABLE XLVIII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- PATIENTS LIVING LESS THAN 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=2,831 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	0.0321	-0.0182	0.0139
	(0.0247)	(0.0327)	(0.0527)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

TABLE XLIX. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX FOR EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- PATIENTS LIVING LESS THAN 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=2,833 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	-0.00772
	(0.0285)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

[d] Where 1 is most urgent and 5 is least urgent.

APPENDIX B (continued)

2. Patients who Live Closer to Hospital- Pooled Cross-Sectional Analysis

The pooled cross-sectional analysis for patients who lived further from the hospital (at least 3 miles) is shown in Tables L to LII. There were no significant findings for any outcomes for these models.

TABLE L. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – POOLED CROSS-SECTIONAL ANALYSIS- PATIENTS LIVING LESS THAN 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=2,561 PATIENT-MONTHS)[a, b, c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	-0.00631	-0.00829	-0.00484	0.000891	0.000046	0.000568
	(0.0166)	(0.0159)	(0.0153)	(0.00776)	(0.00489)	(0.00434)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	-0.00435	0.000693	0.00225	0.00272	0.000063	0.000063
	(0.0137)	(0.0123)	(0.00598)	(0.00553)	(0.00210)	(0.00210)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	-0.0140	-0.0103	-0.00302	-0.00196	0.00597	-0.000721
	(0.0226)	(0.0211)	(0.0152)	(0.0139)	(0.0134)	(0.0109)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

APPENDIX B (continued)

TABLE LI. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- POOLED CROSS-SECTIONAL ANALYSIS - PATIENTS LIVING LESS THAN 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=2,561 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	-0.00825 (0.0140)	0.00309 (0.00857)	-0.00516 (0.0186)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

TABLE LII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX FOR EMERGENCY DEPARTMENT VISIT- POOLED CROSS-SECTIONAL ANALYSIS - PATIENTS LIVING LESS THAN 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=2,561 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	0.00729 (0.0139)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

[d] Where 1 is most urgent and 5 is least urgent

APPENDIX B (continued)

3. Patients who Live Further from Hospital- Patient Fixed Effects

For patients who live at least 3 miles from UI Hospital, there were no significant within patient effects between distance to closest FQHC and non-urgent ED utilization. These results can be found in Tables LIII to LV.

TABLE LIII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – PATIENT FIXED EFFECTS- PATIENTS LIVING AT LEAST 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=2,246 PATIENT-MONTHS)[a, b, c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	0.00669	0.0206	0.0301	0.0170	-0.00481	0.00203
	(0.0481)	(0.0406)	(0.0272)	(0.0180)	(0.00853)	(0.00757)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	-0.00531	0.00318	-0.00970	-0.0102	-0.0130	-0.0130
	(0.0396)	(0.0425)	(0.0266)	(0.0255)	(0.0119)	(0.0119)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	-0.0258	-0.0245	-0.0336	-0.00300	-0.00726	-0.0139
	(0.0362)	(0.0347)	(0.0282)	(0.0331)	(0.0340)	(0.0331)

*** $p<0.01$, ** $p<0.05$
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.

APPENDIX B (continued)

TABLE LIV. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- PATIENTS LIVING AT LEAST 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=2,246 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	0.00437	-0.0132	-0.00883
	(0.0327)	(0.0320)	(0.0183)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

TABLE LV. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX FOR EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- PATIENTS LIVING AT LEAST 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=2,241 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	0.00985
	(0.0352)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

[d] Where 1 is most urgent and 5 is least urgent.

APPENDIX B (continued)

4. Patients who Live Further from Hospital- Pooled Cross-Sectional Analysis

For patients who lived further from the hospital (at least 3 miles), there were some significant associations across patients in the pooled cross-sectional model. There was significant associations between distance to closest FQHC and 90% PCT visits, 95% PCT visits, and 95% NEPCT visits. Each of the significant coefficients were negative in the linear probability model, so a logistic regression model was run in order to be able to interpret the association. The logistic regression models for the outcomes of 90% and 95% PCT both had odds ratios of 0.509. This means that as distance to closest FQHC increased by one quarter mile, the odds of having a 90% PCT visit decreased by 49%. Similarly, as the distance to closest FQHC increased by one quarter mile, the odds of having a 95% PCT visit decreased by 49%.

The outcome of 95% NEPCT visits had an odds ratio of 0.829 in the logistic regression model, meaning that as the distance to closest FQHC increased by one quarter mile, the odds of having a 95% NEPCT visit decreased by 17%. These findings of an inverse relationship between distance and non-urgent ED utilization differed from the initial hypothesis that as distance to closest FQHC decreased, non-urgent ED utilization would also decrease.

There were no significant findings in Tables LVII or LVIII, which looked at the outcomes of continuous mean probability for non-urgent NYU algorithm indicators and ESI level for patients who lived at least 3 miles from UI Hospital, using pooled cross-sectional analysis.

APPENDIX B (continued)

TABLE LVI. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – POOLED CROSS-SECTIONAL ANALYSIS - PATIENTS LIVING AT LEAST 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=1,949 PATIENT-MONTHS)[a, b, c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	0.00577	0.00722	0.0107	0.000412	-0.000685	-0.00240
	(0.00897)	(0.00876)	(0.00852)	(0.00560)	(0.00382)	(0.00274)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	-0.00354	-0.00426	-0.00230	-0.00289	-0.00565**	-0.00565**
	(0.0165)	(0.0154)	(0.00432)	(0.00330)	(0.00209)	(0.00209)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	0.000828	-0.00267	-0.00475	-0.000406	-0.0109	-0.0117***
	(0.0115)	(0.0120)	(0.0106)	(0.00957)	(0.00669)	(0.00351)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

APPENDIX B (continued)

TABLE LVII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- POOLED CROSS-SECTIONAL ANALYSIS - PATIENTS LIVING AT LEAST 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=1,949 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	0.00506	-0.00310	0.00196
	(0.00762)	(0.00782)	(0.00720)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.

TABLE LVIII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX FOR EMERGENCY DEPARTMENT VISIT- POOLED CROSS-SECTIONAL ANALYSIS - PATIENTS LIVING AT LEAST 3 MILES FROM UNIVERSITY OF ILLINOIS HOSPITAL- JANUARY 2009-DECEMBER 2012 (N=1,944 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	0.00611
	(0.0153)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.
[d] Where 1 is most urgent and 5 is least urgent.

APPENDIX B (continued)

In conclusion, there were some significant findings when the study sample was stratified by distance to UI Hospital. For patients who lived near the hospital, there were significant findings for the patient fixed effect models at some non-urgent thresholds. The findings suggest that as distance to closest FQHC decreased, the probability of non-emergent ED utilization also decreased, when looking at changes within patient. Since there were no significant findings for these outcomes for the study sample as a whole, it is possible that patients who live closer to the hospital are more aware of new healthcare resources than those who live further away, and perhaps UI Hospital and other nearby hospitals may better communicate these alternative health resources to patients who live nearby. They may also have more transportation options than patients who live further from the hospital, because of the central location of the hospital.

For patients who lived further from the hospital, there were significant findings in the pooled cross-sectional analysis, where there was an inverse association between distance to closest FQHC and non-urgent ED utilization. This meant that as distance increased, the probability of non-emergent and primary care treatable ED visits decreased. This may suggest that, across patients, patients who lived further from UI Hospital may have a preference to travel further for their care, as they did for their visits to UI Hospital.

APPENDIX B (continued)

Sub-Analysis: Stratified Analysis Based on Patient's Distance Change to Closest FQHC

A second sub-analysis was completed that stratified the study sample according to their amount of distance change to the closest FQHC from their home. For patients who had a distance change, the mean distance change was 1.1 quarter miles. Patients with a distance change were grouped into two groups- those with less than 1.1 quarter mile distance change, and those with at least 1.1 quarter mile distance change. The models for each group were the same as those used in the main analysis, where linear regression models were run two ways- as 1) patient fixed effects models, and 2) pooled cross-sectional models. Standard errors were clustered by patient zip code.

1. **Patients with Distance Change Less than 1.1 Quarter Miles- Patient Fixed Effects**

Table LIX shows the association between distance to closest FQHC and probability of having a non-urgent ED visit for patients with a distance change of less than 1.1 quarter miles, with patient fixed effects. For this model, there was one significant association for the outcomes of 90% NE visits. Across patients who had a small distance change, a one-quarter mile increase in distance to closest FQHC was associated with an 8% increase in the probability that the ED visit was above the 90% non-emergent (NE) threshold. This finding support the original hypothesis that as distance to FQHC decreases, probability of non-urgent ED utilization also decreases.

Table LX shows that there was no significant association between distance to closest FQHC and continuous mean probability of non-urgent ED visits for patients with a small distance change, in a patient fixed effects model.

APPENDIX B (continued)

TABLE LIX. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – PATIENT FIXED EFFECTS- PATIENTS WITH DISTANCE CHANGE LESS THAN 1.1 QUARTER MILES- JANUARY 2009-DECEMBER 2012 (N=302 PATIENT-MONTHS)[a, b, c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	0.0124	0.0970	0.169	0.125	0.0794**	0.0555
	(0.129)	(0.115)	(0.117)	(0.0962)	(0.0309)	(0.0282)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	-0.0234	0.00684	0.00942	0.0346	0.00722	0.00722
	(0.0895)	(0.0780)	(0.0478)	(0.0515)	(0.0278)	(0.0278)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	0.0234	0.0600	0.0313	0.0745	-0.0110	-0.0550
	(0.126)	(0.120)	(0.0962)	(0.102)	(0.117)	(0.0834)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

TABLE LX. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- PATIENTS WITH DISTANCE CHANGE LESS THAN 1.1 QUARTER MILES - JANUARY 2009-DECEMBER 2012 (N=302 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	0.0510	-0.00640	0.0446
	(0.0905)	(0.0664)	(0.0831)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

APPENDIX B (continued)

Table LXI shows that there was no significant association between distance to closest FQHC and ESI for patients with a small distance change, in a patient fixed effects model.

TABLE LXI. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX FOR EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- PATIENTS WITH DISTANCE CHANGE LESS THAN 1.1 QUARTER MILES - JANUARY 2009-DECEMBER 2012 (N=302 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	-0.0224 (0.180)

*** $p<0.01$, ** $p<0.05$
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.
[d] Where 1 is most urgent and 5 is least urgent.

2. <u>Patients with Distance Change Less than 1.1 Quarter Miles- Pooled Cross-Sectional Analysis</u>

Table LXII shows that there was no significant association between distance to closest FQHC and probability of a non-urgent ED visit for patients with a small distance change, in a pooled cross-sectional model.

Table LXIII shows that there was no significant association between distance to closest FQHC and continuous mean probability of non-urgent ED visits for patients with a small distance change, in a pooled cross-sectional model.

APPENDIX B (continued)

TABLE LXII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – POOLED CROSS-SECTIONAL ANALYSIS- PATIENTS WITH DISTANCE CHANGE LESS THAN 1.1 QUARTER MILES- JANUARY 2009-DECEMBER 2012 (N=287 PATIENT-MONTHS)[a, b, c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	-0.00519	-0.0170	-0.0176	-0.00127	0.00334	0.00570
	(0.0476)	(0.0456)	(0.0400)	(0.0101)	(0.00711)	(0.00646)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	0.0166	0.0177	0.0315	0.0252	0.00996	0.00996
	(0.0125)	(0.0129)	(0.0159)	(0.0133)	(0.00712)	(0.00712)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	0.00691	0.00741	0.0180	0.0127	0.0202	-0.00583
	(0.0560)	(0.0535)	(0.0472)	(0.0430)	(0.0210)	(0.0193)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

TABLE LXIII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- POOLED CROSS-SECTIONAL ANALYSIS - PATIENTS WITH DISTANCE CHANGE LESS THAN 1.1 QUARTER MILES - JANUARY 2009-DECEMBER 2012 (N=287 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	-0.00681	0.0192	0.0124
	(0.0391)	(0.0103)	(0.0448)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

APPENDIX B (continued)

Table LXIV shows that there was no significant association between distance to closest FQHC and ESI for patients with a small distance change, in a pooled cross-sectional model.

TABLE LXIV. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX FOR EMERGENCY DEPARTMENT VISIT- POOLED CROSS-SECTIONAL ANALYSIS - PATIENTS WITH DISTANCE CHANGE LESS THAN 1.1 QUARTER MILES - JANUARY 2009-DECEMBER 2012 (N=287 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	-0.000327 (0.0662)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

[d] Where 1 is most urgent and 5 is least urgent.

3. <u>Patients with Distance Change At Least 1.1 Quarter Miles- Patient Fixed Effects</u>

Table LXV shows the association between distance to closest FQHC and probability of having a non-urgent ED visit for patients with a larger distance change, using a patient fixed effects model. While Table LXV shows that there was a significant association between distance to closest FQHC and probability of having a 90% NE visit in the linear probability model, the coefficient was negative. Since the probability cannot be a negative number, we tried to run the

APPENDIX B (continued)

analysis using logistic and conditional logistic regression. However, the models did not converge using logistic or conditional logistic regression. Using conditional logistic regression, the variance matrix was "nonsymmetric or highly singular". When specification of clustering standard errors by patient zip code was removed from the model, relationship was not significant (p=0.999).

TABLE LXV. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – PATIENT FIXED EFFECTS- PATIENTS WITH DISTANCE CHANGE AT LEAST 1.1 QUARTER MILES- JANUARY 2009-DECEMBER 2012 (N=203 PATIENT-MONTHS)[a, b, c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	0.0508	0.0185	-0.0125	-0.0113	-0.0318**	-0.0186
	(0.0833)	(0.0842)	(0.0589)	(0.0172)	(0.0132)	(0.00890)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	0.0251	0.0569	-0.0140	-0.0140	-0.0202	-0.0202
	(0.0888)	(0.102)	(0.0472)	(0.0472)	(0.0133)	(0.0133)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	0.0209	0.0228	-0.0413	0.0165	-0.0322	-0.0435
	(0.0564)	(0.0586)	(0.0575)	(0.0705)	(0.0560)	(0.0294)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.

APPENDIX B (continued)

Table LXVI shows that there was no significant association between distance to closest FQHC and continuous mean probability of non-urgent ED visits for patients with a larger distance change, in a patient fixed effects model.

Table LXVII shows that there was no significant association between distance to closest FQHC and ESI for patients with a larger distance change, in a patient fixed effects model.

TABLE LXVI. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- PATIENTS WITH DISTANCE CHANGE AT LEAST 1.1 QUARTER MILES - JANUARY 2009-DECEMBER 2012 (N=203 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	0.00679	0.00275	0.00954
	(0.0564)	(0.0640)	(0.0354)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.

TABLE LXVII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX FOR EMERGENCY DEPARTMENT VISIT- PATIENT FIXED EFFECTS- PATIENTS WITH DISTANCE CHANGE AT LEAST 1.1 QUARTER MILES - JANUARY 2009-DECEMBER 2012 (N=203 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	0.0795
	(0.0720)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for age, insurance type, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.
[d] Where 1 is most urgent and 5 is least urgent.

APPENDIX B (continued)

4. <u>Patients with Distance Change At Least 1.1 Quarter Miles- Pooled Cross-Sectional Analysis</u>

Table LXVIII shows the association between distance to closest FQHC and probability of having a non-urgent ED visit for patients with a larger distance change, using a pooled cross-sectional model. Significant findings were found for the outcomes of 60% PCT and 90% NEPCT. For 60% PCT, a one-quarter mile increase in distance to closest FQHC was associated with a 10% increase in the probability that the ED visit was above the 60% PCT threshold. For 90% NEPCT, the coefficient was negative, so a logistic regression model was run in order to interpret this finding. The resulting, significant odds ratio was 0.345, meaning that as the distance to closest FQHC increased by one quarter mile, the odds of having a 90% NEPCT visit decreased by about 65%.

Table LXIX shows that there was no significant association between distance to closest FQHC and continuous mean probability of non-urgent ED visits for patients with a larger distance change, in a pooled cross-sectional model.

Table LXX shows that there was no significant association between distance to closest FQHC and ESI for patients with a larger distance change, in a pooled cross-sectional model.

APPENDIX B (continued)

TABLE LXVIII. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND PROBABILITY OF HAVING A NON-EMERGENT, PRIMARY CARE TREATABLE, OR NON-EMERGENT+PRIMARY CARE TREATABLE EMERGENCY DEPARTMENT VISIT – POOLED CROSS-SECTIONAL ANALYSIS- PATIENTS WITH DISTANCE CHANGE AT LEAST 1.1 QUARTER MILES- JANUARY 2009-DECEMBER 2012 (N=175 PATIENT-MONTHS)[a, b, c]

VARIABLES	50%	60%	70%	80%	90%	95%
NON-EMERGENT (NE) VISITS						
Distance to Closest FQHC	-0.0816	-0.0863	-0.0624	-0.0371	-0.0248	-0.00449
	(0.0441)	(0.0490)	(0.0460)	(0.0168)	(0.0155)	(0.00963)
PRIMARY CARE TREATABLE (PCT) VISITS						
Distance to Closest FQHC	0.0674	0.0981**	0.0113	0.0113	0.00272	0.00272
	(0.0540)	(0.0397)	(0.0154)	(0.0154)	(0.00731)	(0.00731)
NON-EMERGENT+ PRIMARY CARE TREATABLE (NEPCT) VISITS						
Distance to Closest FQHC	-0.0494	-0.0444	-0.114	-0.101	-0.0881***	-0.0450
	(0.0589)	(0.0590)	(0.0530)	(0.0461)	(0.0196)	(0.0289)

*** p<0.01, ** p<0.05

[a] Standard errors in parentheses, clustered by patient zip code.

[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.

[c] Coefficients are reported from linear regressions.

APPENDIX B (continued)

TABLE LXIX. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND CONTINUOUS MEAN PROBABILITY (%) OF NON-EMERGENT (NE), PRIMARY CARE TREATABLE (PCT) AND NON-EMERGENT+PRIMARY CARE TREATABLE (NEPCT) EMERGENCY DEPARTMENT VISIT- POOLED CROSS-SECTIONAL ANALYSIS - PATIENTS WITH DISTANCE CHANGE AT LEAST 1.1 QUARTER MILES - JANUARY 2009-DECEMBER 2012 (N=175 PATIENT-MONTHS)[a, b, c]

VARIABLES	NE	PCT	NEPCT
Distance to Closest FQHC	-0.0704 (0.0355)	0.0164 (0.0234)	-0.0540 (0.0275)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.

TABLE LXX. ASSOCIATION BETWEEN DISTANCE TO CLOSEST FEDERALLY QUALIFIED HEALTH CENTER (FQHC) (IN QUARTER MILES) AND MEAN EMERGENCY SEVERITY INDEX FOR EMERGENCY DEPARTMENT VISIT- POOLED CROSS-SECTIONAL ANALYSIS - PATIENTS WITH DISTANCE CHANGE AT LEAST 1.1 QUARTER MILES - JANUARY 2009-DECEMBER 2012 (N=175 PATIENT-MONTHS)[a, b, c]

VARIABLE	ESI[d]
Distance to Closest FQHC	0.0720 (0.0586)

*** p<0.01, ** p<0.05
[a] Standard errors in parentheses, clustered by patient zip code.
[b] All regressions included variables that controlled for race, ethnicity, gender, age, insurance type, 2011 zip code level poverty rate, month of visit, and year of visit.
[c] Coefficients are reported from linear regressions.
[d] Where 1 is most urgent and 5 is least urgent.

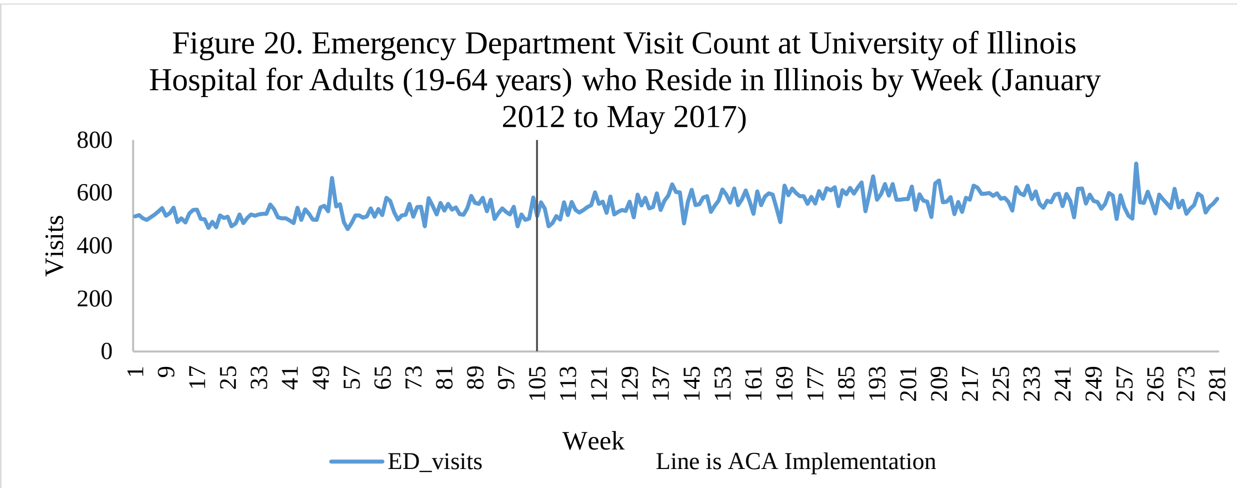
APPENDIX B (continued)

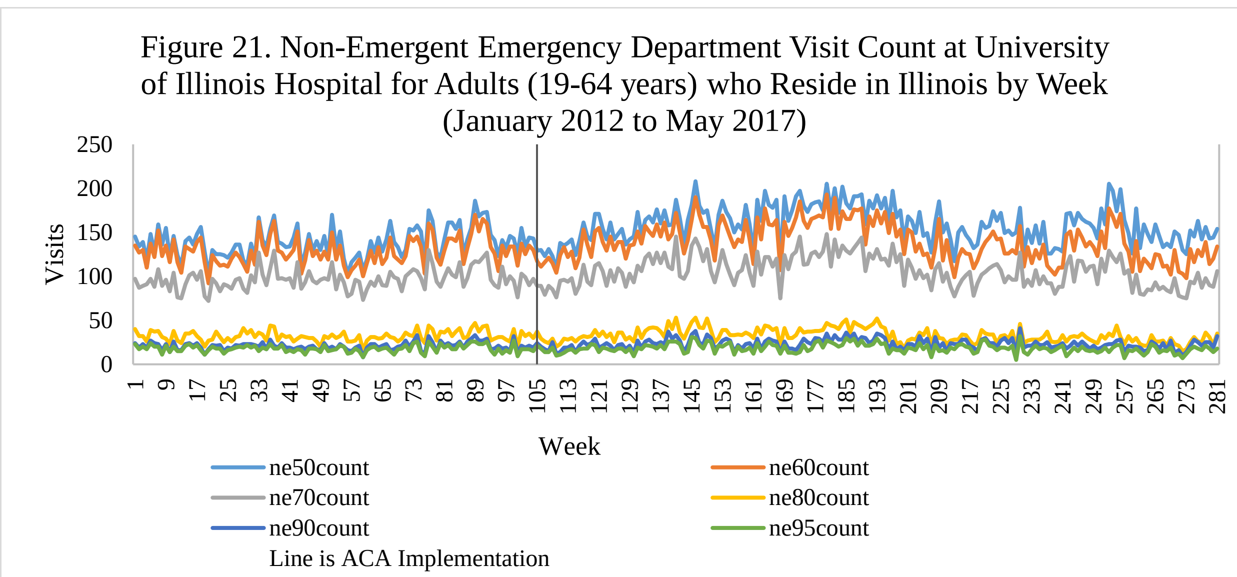
In conclusion, there were some significant findings when stratifying the study sample by amount of distance change. For patients with a small distance change, the patient fixed effects models had one threshold that had a significant finding. This finding showed that an increase in distance was associated with an increase in probability of an ED visit, which supported the hypothesis. There were significant findings for two outcomes for the patients who had larger distance changes, in the pooled cross-sectional analysis models. One outcome showed that there was an inverse relationship between distance to closest FQHC and probability of non-urgent ED utilization, and the other finding showed that this association went in the same direction. While there proved to be some significant findings for certain groups and certain non-urgent ED visit thresholds in this analysis, the results did not provide a consensus for the relationship between distance to FQHC and non-urgent ED utilization, so more research is needed to determine if a true relationship exists.

APPENDIX C

Visit Count by Week for All Eligible Study Patients (January 2012 to May 2017)

Note: All count graphs exclude week 282 because it was not a complete week (May 2017 ended mid-week).





APPENDIX C (continued)

Figure 22. Primary Care Treatable Emergency Department Visit Count at University of Illinois Hospital for Adults (19-64 years) who Reside in Illinois by Week (January 2012 to May 2017)

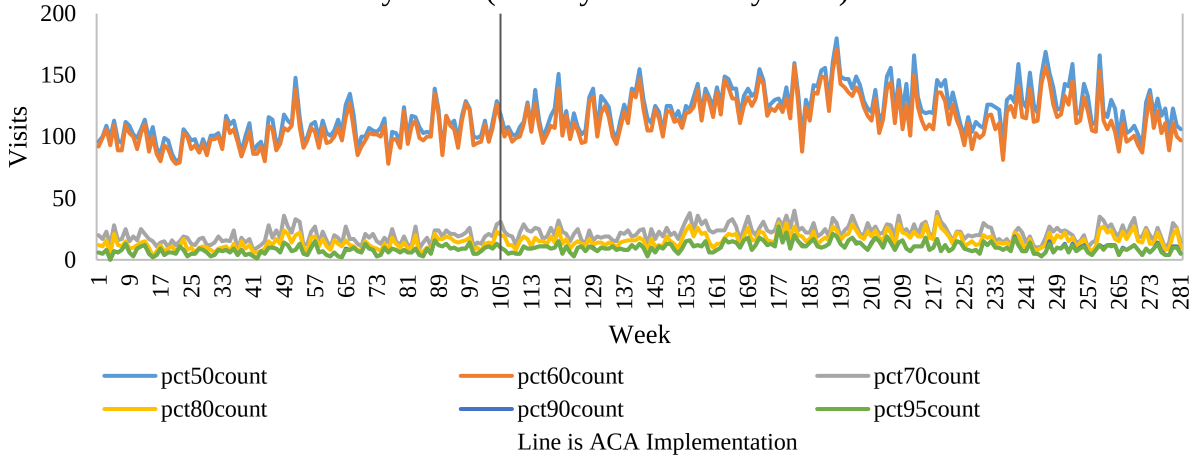
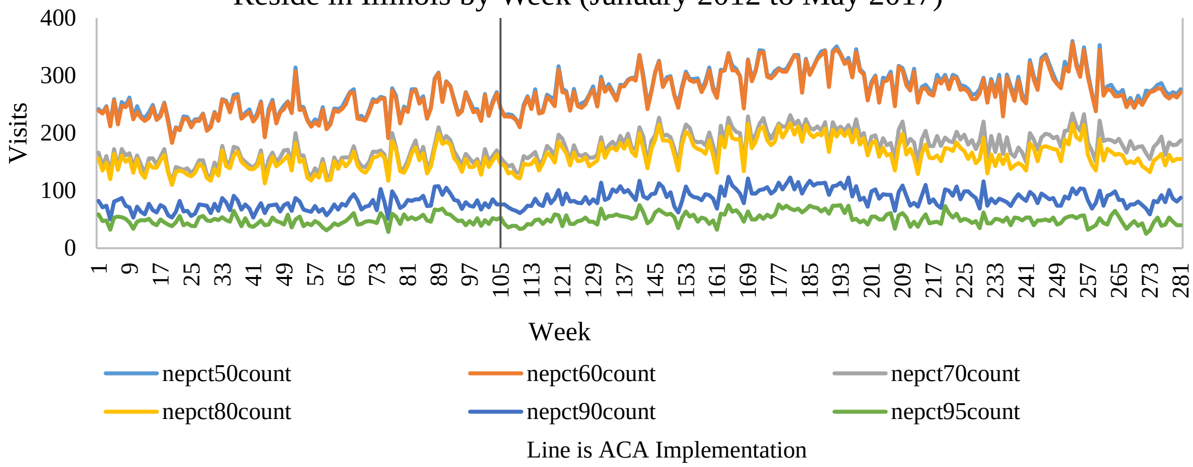
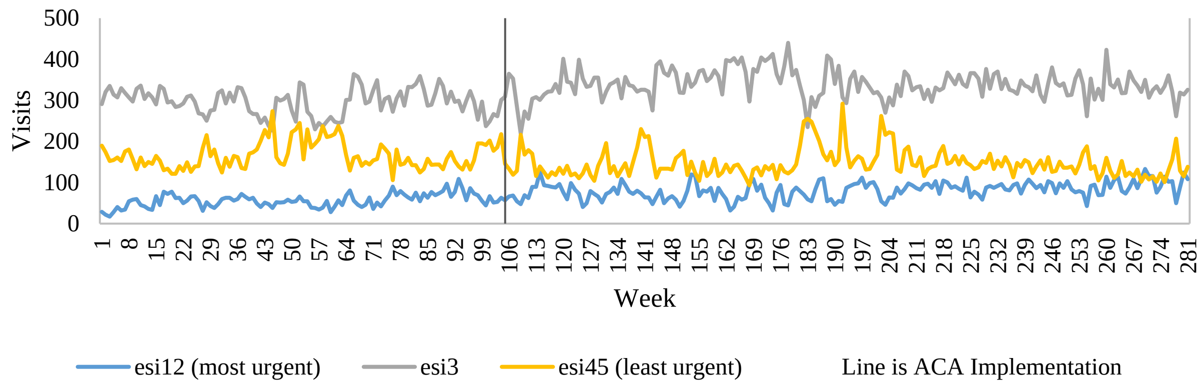


Figure 23. Non-Emergent + Primary Care Treatable Emergency Department Visit Count at University of Illinois Hospital for Adults (19-64 years) who Reside in Illinois by Week (January 2012 to May 2017)



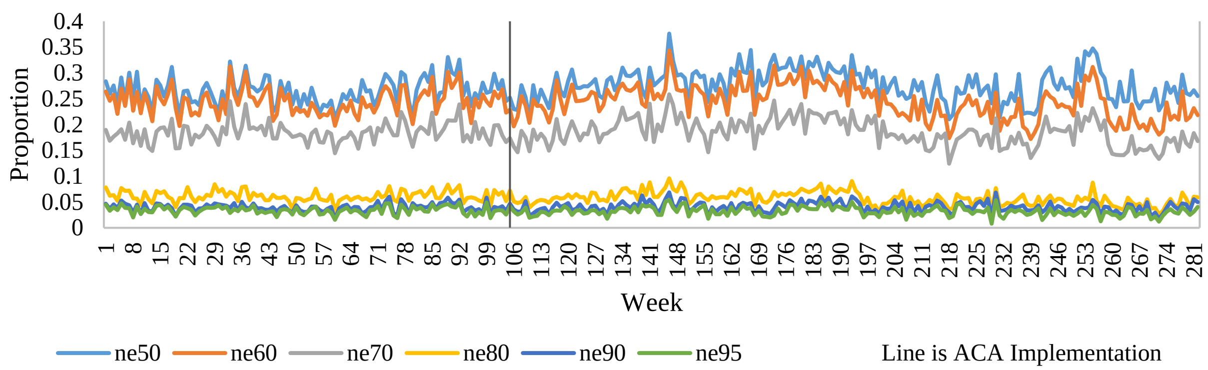
APPENDIX C (continued)

Figure 24. Emergency Department Visit Count by Emergency Severity Index (ESI) at University of Illinois Hospital for Adults (19-64 years) who Reside in Illinois by Week (January 2012 to May 2017)



__Visit Proportion by Week for All Eligible Study Patients (January 2012 to May 2017)__

Figure 25. Proportion of Non-Emergent Emergency Department Visits at University of Illinois Hospital for Adults (19-64 years) who Reside in Illinois by Week (January 2012 to May 2017)



APPENDIX C (continued)

Figure 26. Proportion of Primary Care Treatable Emergency Department Visits at University of Illinois Hospital for Adults (19-64 years) who Reside in Illinois by Week (January 2012 to May 2017)

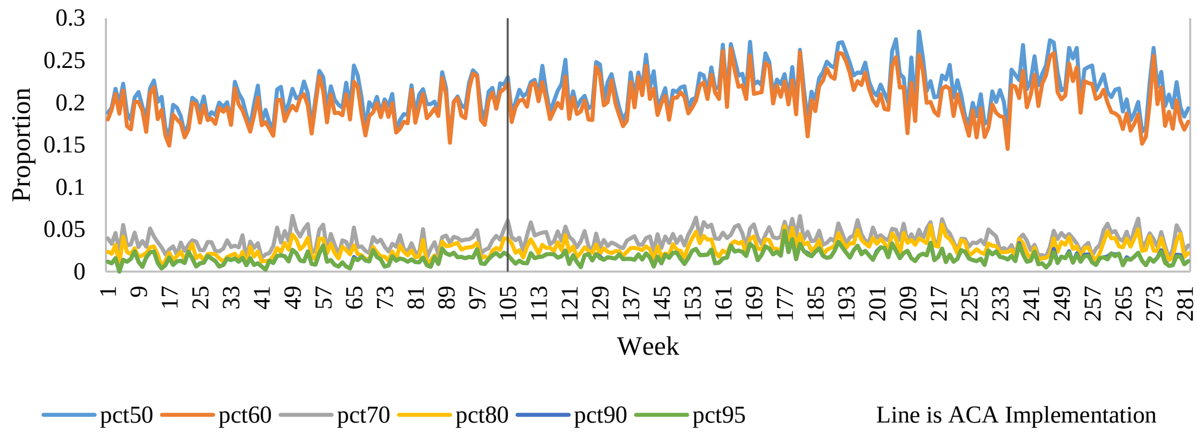
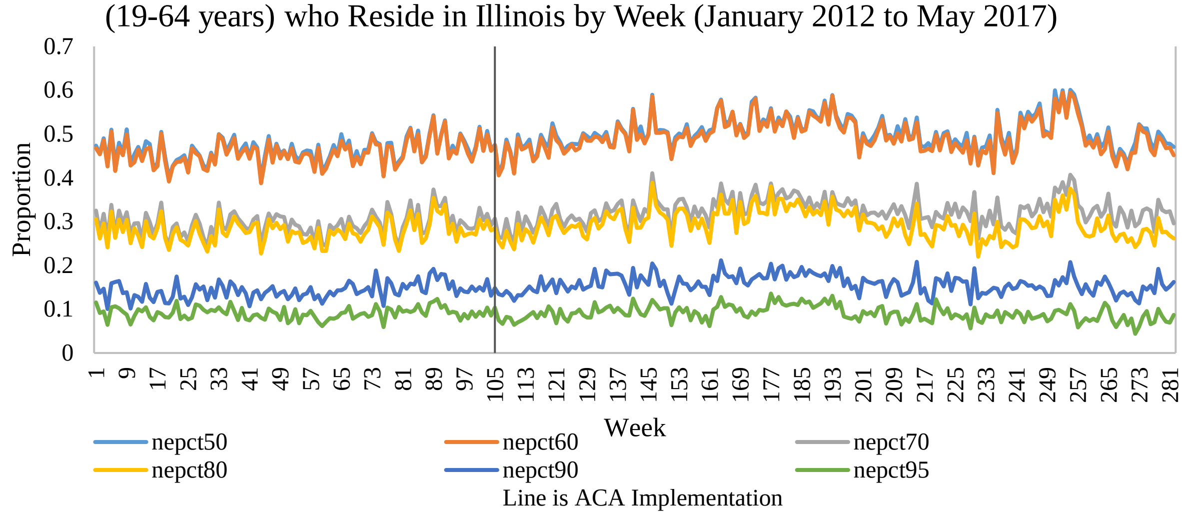


Figure 27. Proportion of Non-Emergent + Primary Care Treatable Emergency Department Visits at University of Illinois Hospital for Adults (19-64 years) who Reside in Illinois by Week (January 2012 to May 2017)



APPENDIX C (continued)

Figure 28. Continuous Mean Proportion of NE, PCT, and NEPCT Emergency Department Visits at University of Illinois Hospital for Adults (19-64 years) who Reside in Illinois by Week (January 2012 to May 2017)

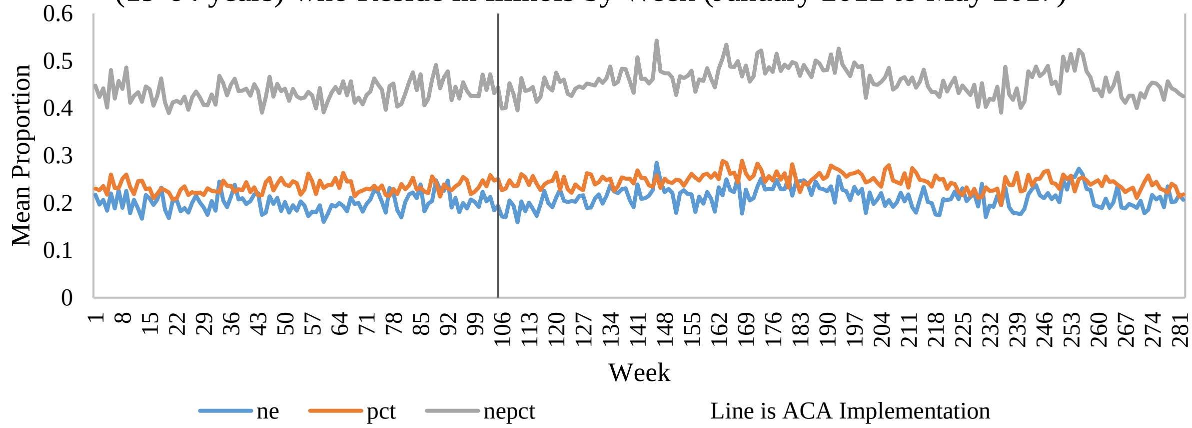
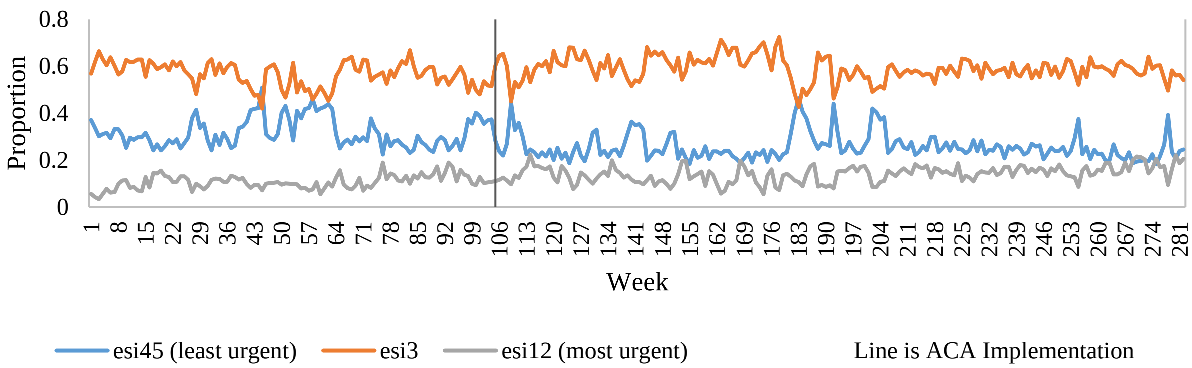


Figure 29. Proportion of Emergency Department Visits by Emergency Severity Index at University of Illinois Hospital for Adults who Reside in Illinois by Week (January 2012 to May 2017)



APPENDIX C (continued)

Plots of Interrupted Time Series Analysis for Outcomes with Significant Change

Figure 30. Actual and Predicted Values by Week for Proportion Primary Care Treatable ED Visits (%) Surrounding Implementation of the Affordable Care Act- All- January 2012 to May 2017- PCT60 from Table XX

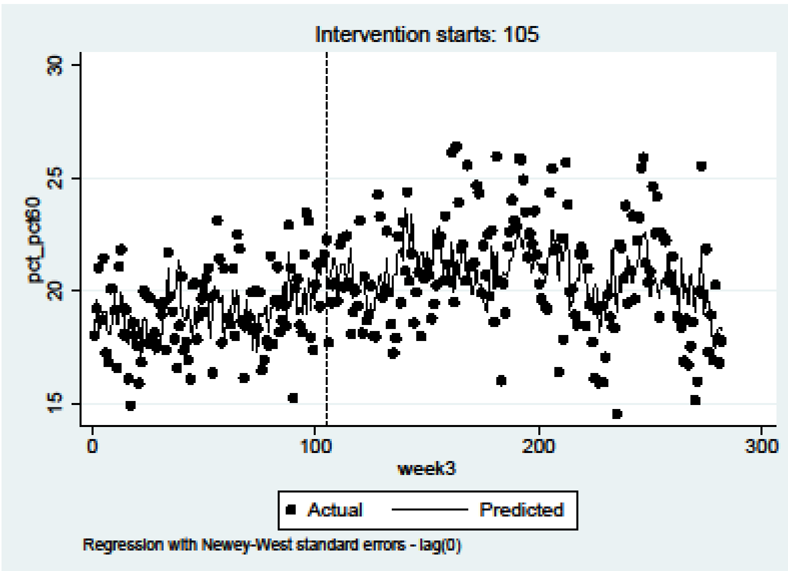
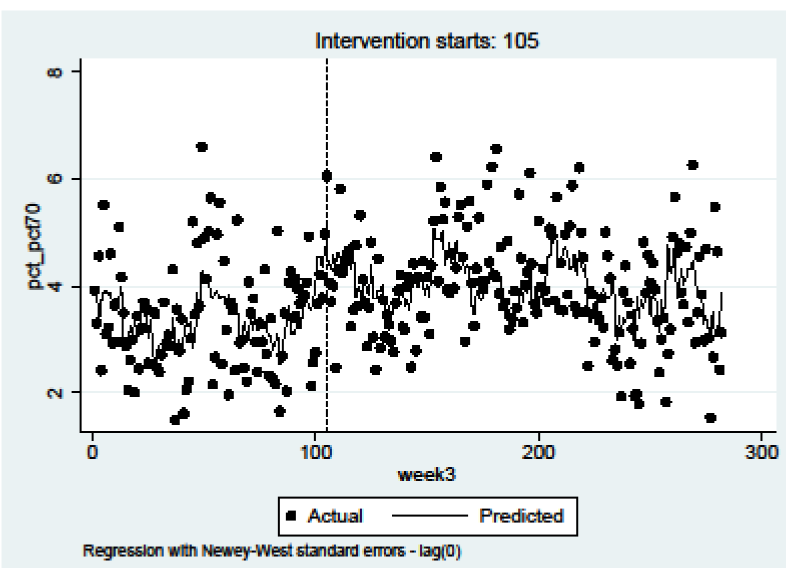


Figure 31. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105) - All- January 2012 to May 2017- PCT70 from Table XX



APPENDIX C (continued)

Figure 32. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- All- January 2012 to May 2017- PCT80 from Table XX

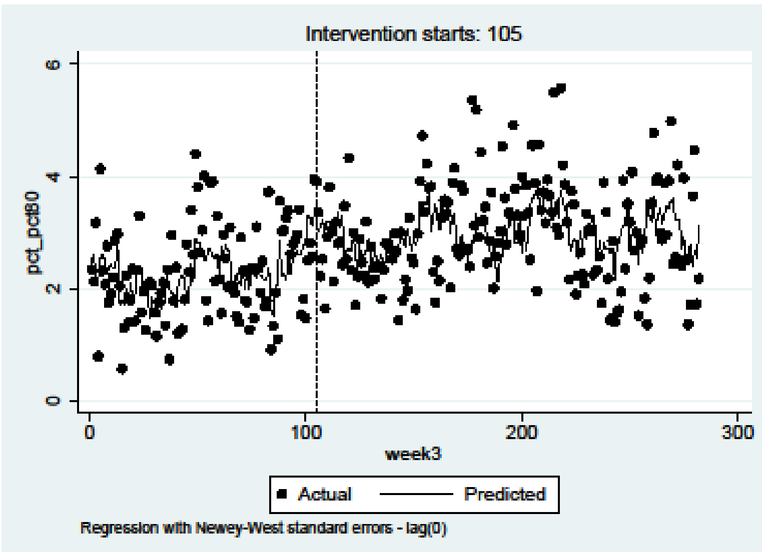
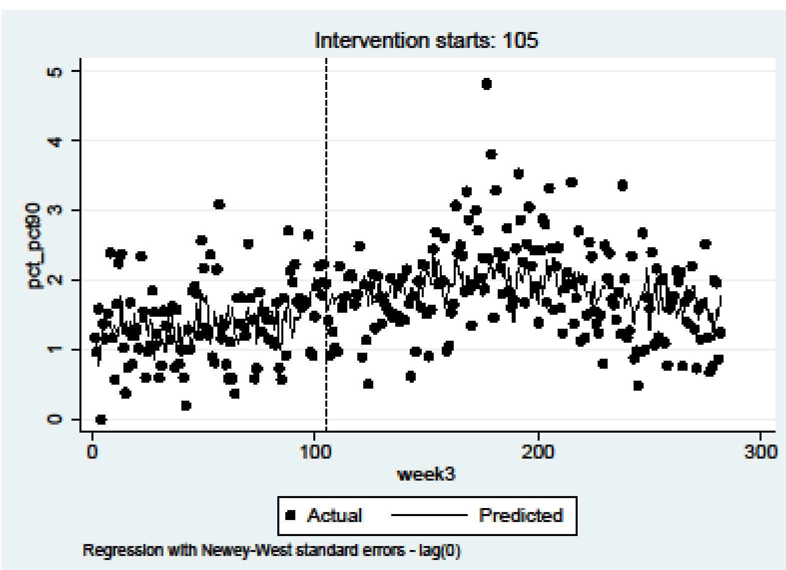


Figure 33. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- All- January 2012 to May 2017- PCT90 from Table XX



APPENDIX C (continued)

Figure 34. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- All- January 2012 to May 2017- PCT95 from Table XX

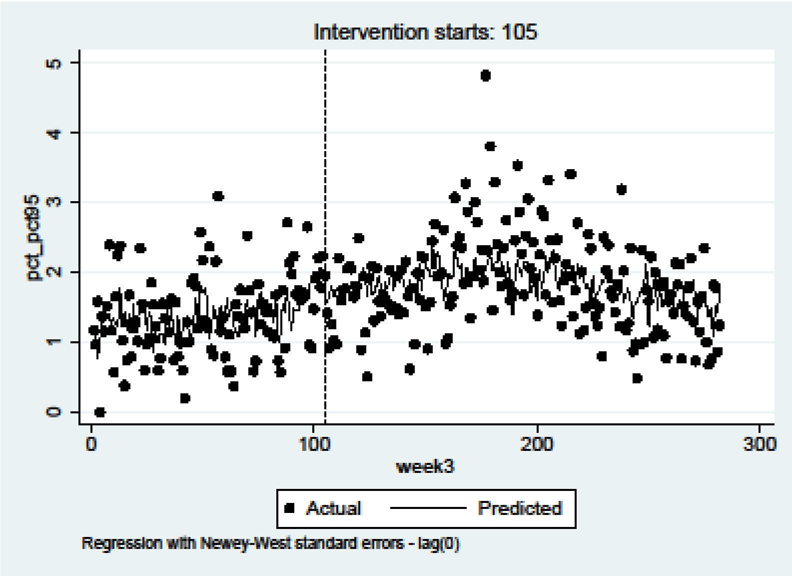
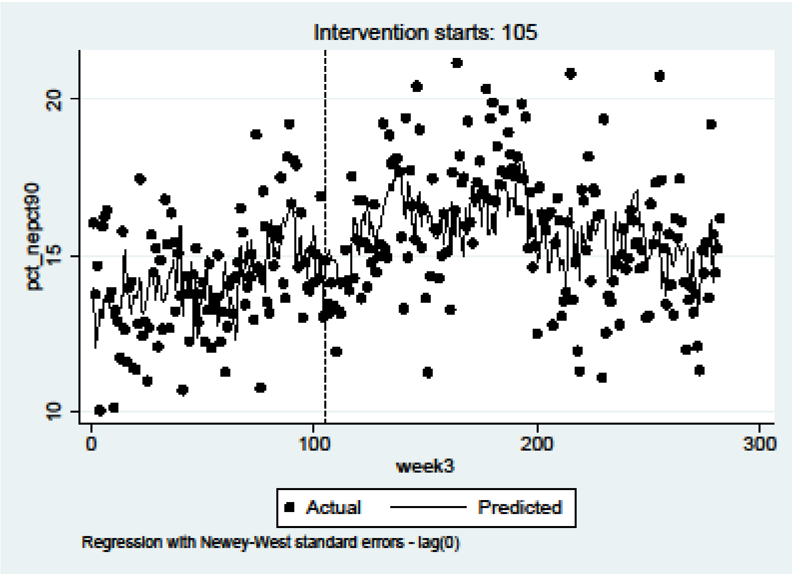


Figure 35. Actual and Predicted Values by Week for Proportion Non-Emergent + Primary Care Treatable ED Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- All- January 2012 to May 2017- NEPCT90 from Table XX



APPENDIX C (continued)

Figure 36. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits by Continuous Mean (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- All- January 2012 to May 2017- PCT from Table XXI

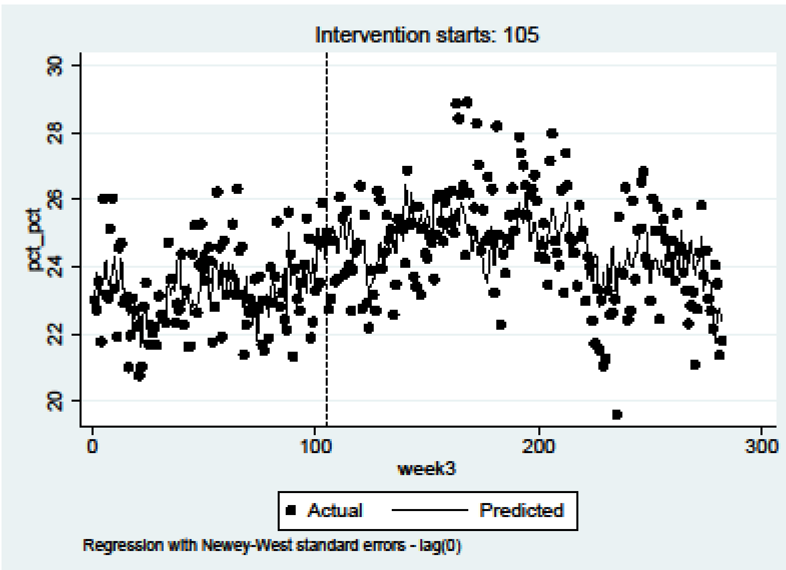
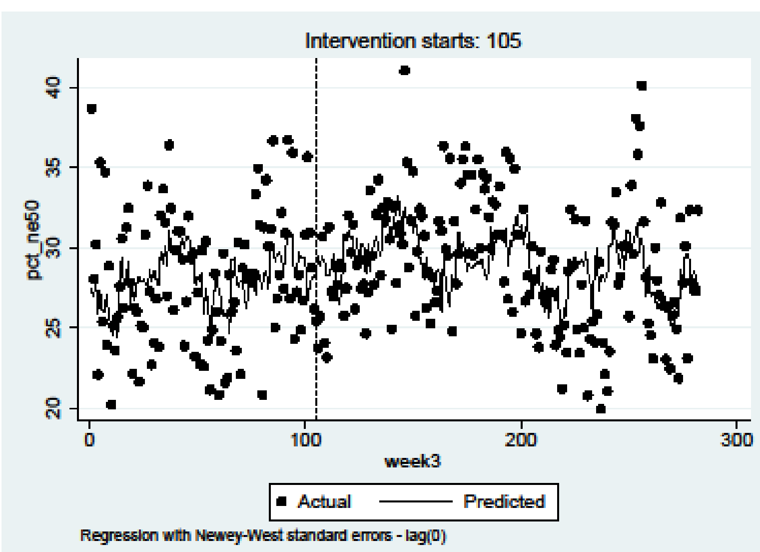


Figure 37. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients- January 2012 to May 2017- NE50 from Table XXIII



APPENDIX C (continued)

Figure 38. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NE60 from Table XXIII

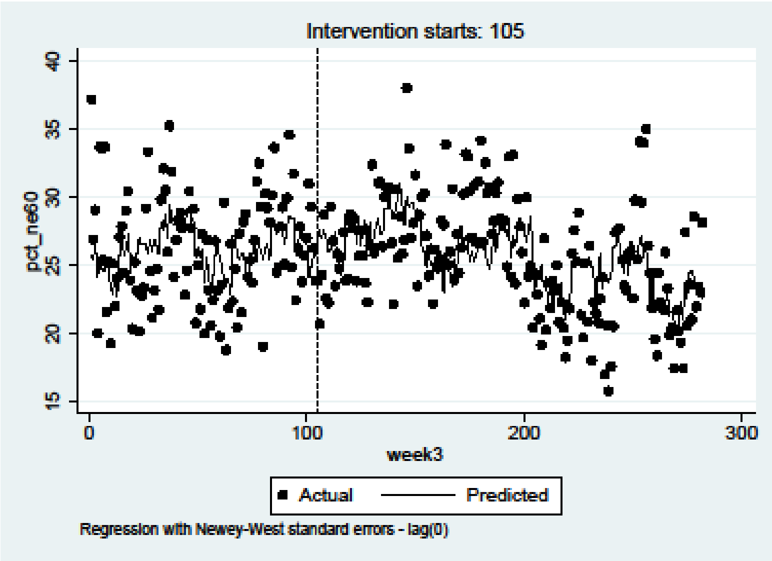
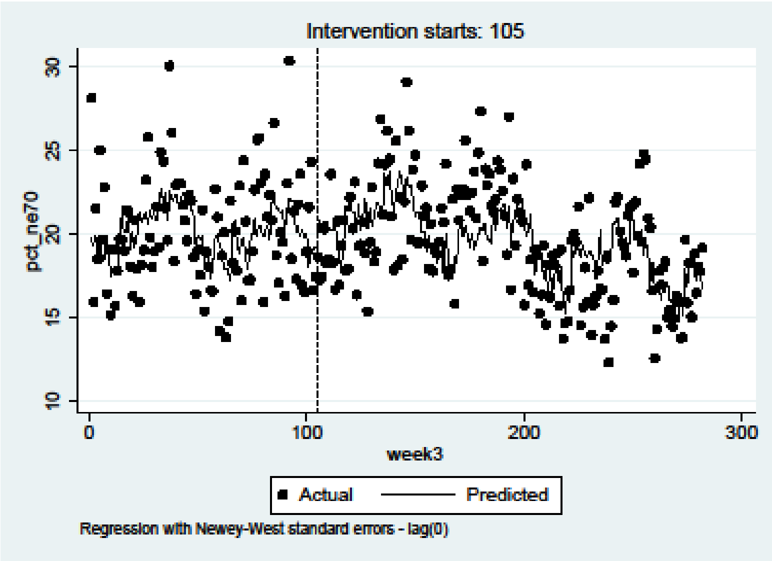


Figure 39. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NE70 from Table XXIII



APPENDIX C (continued)

Figure 40. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NE80 from Table XXIII

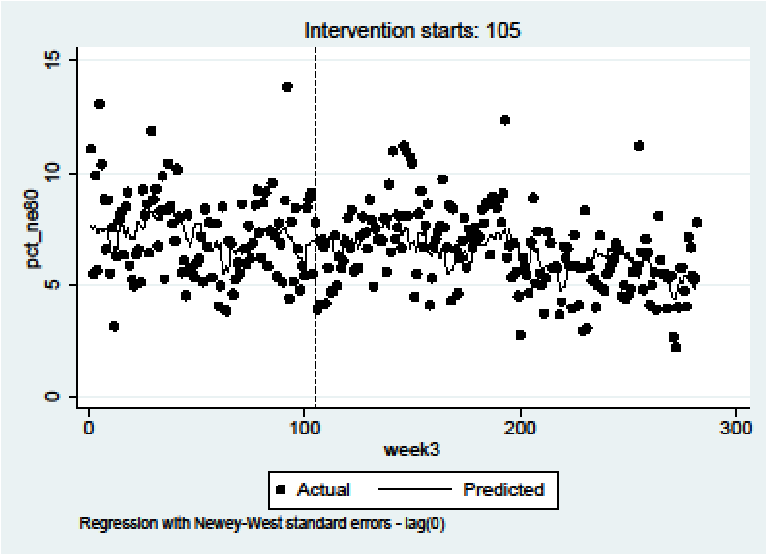
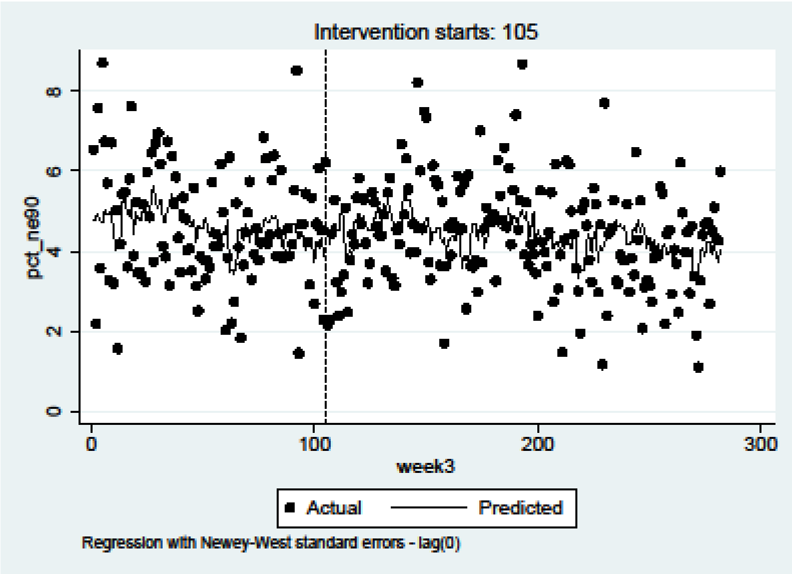


Figure 41. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NE90 from Table XXIII



APPENDIX C (continued)

Figure 42. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NE95 from Table XXIII

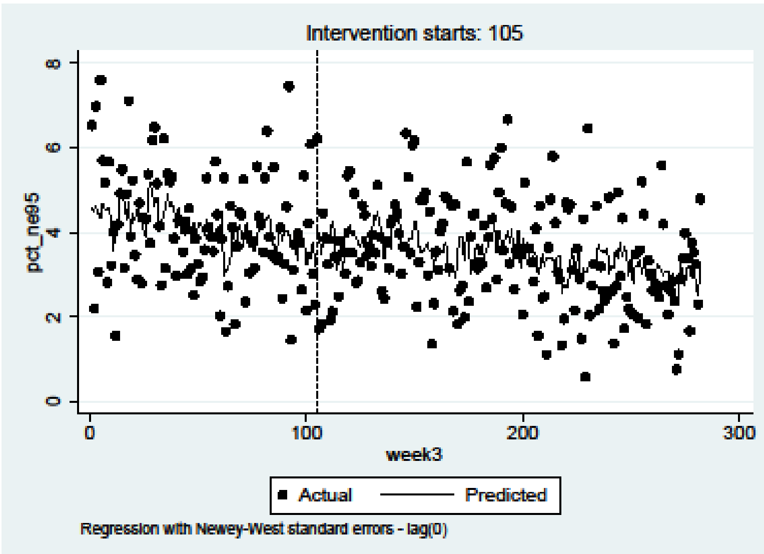
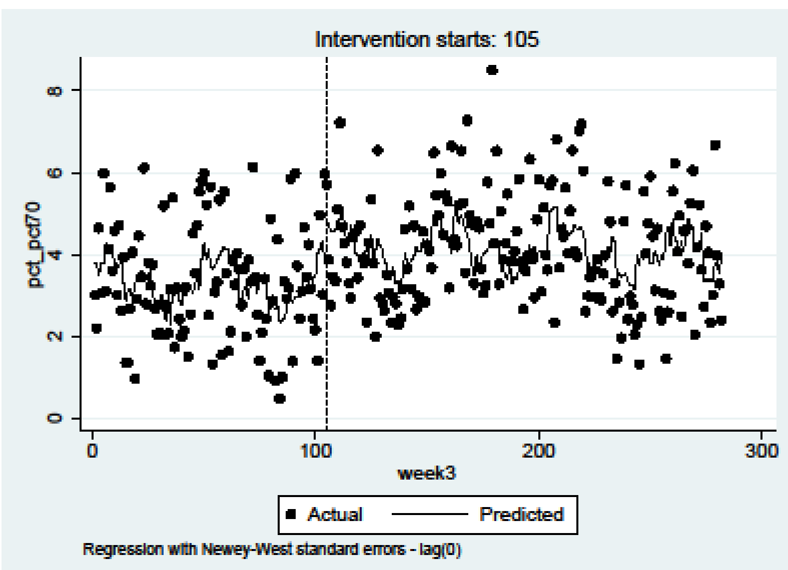


Figure 43. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- PCT70 from Table XXIII



APPENDIX C (continued)

Figure 44. Actual and Predicted Values by Week for Proportion Non-Emergent + Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NEPCT50 from Table XXIII

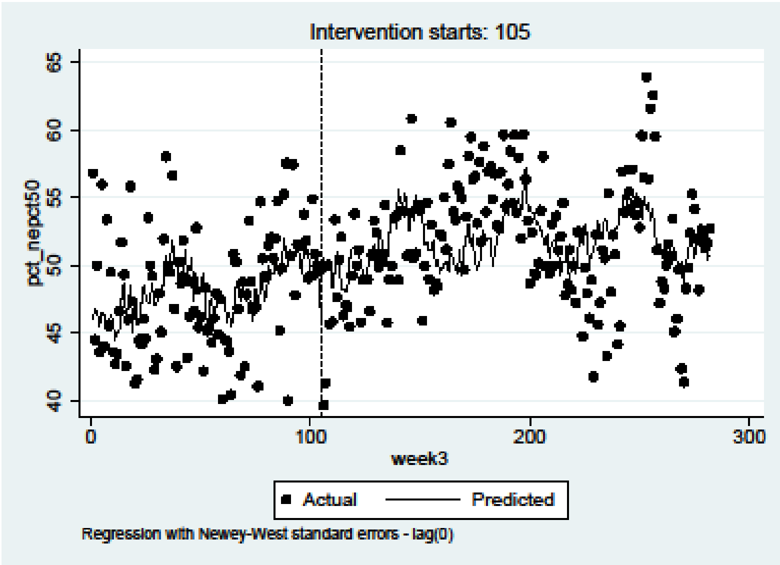
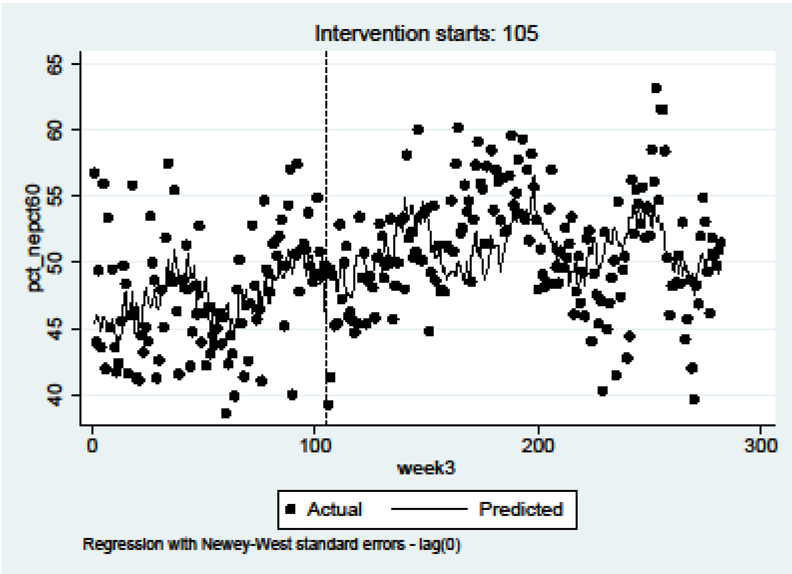


Figure 45. Actual and Predicted Values by Week for Proportion Non-Emergent + Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NEPCT60 from Table XXIII



APPENDIX C (continued)

Figure 46. Actual and Predicted Values by Week for Proportion Non-Emergent + Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NEPCT70 from Table XXIII

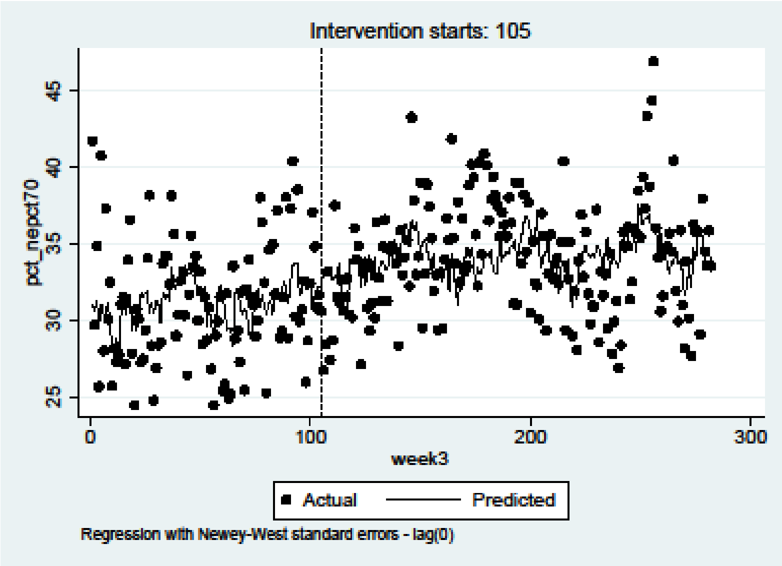
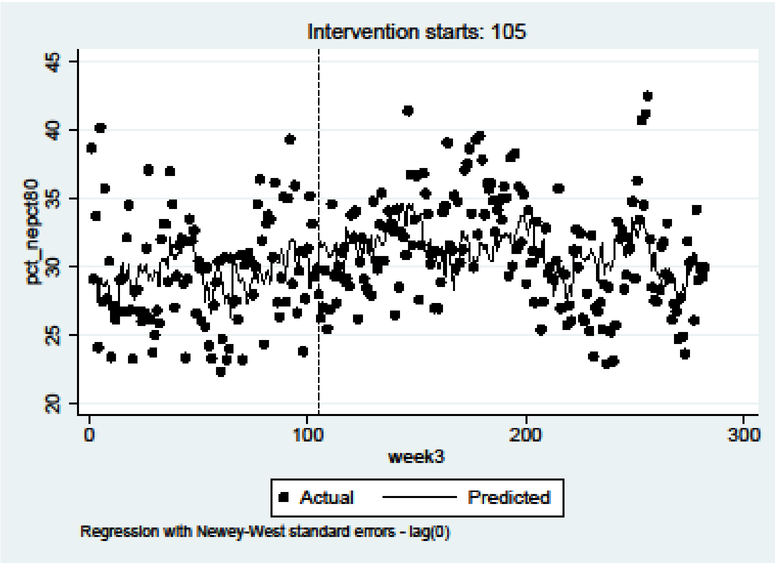


Figure 47. Actual and Predicted Values by Week for Proportion Non-Emergent + Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NEPCT80 from Table XXIII



APPENDIX C (continued)

Figure 48. Actual and Predicted Values by Week for Proportion Non-Emergent + Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)-Medicaid Patients - January 2012 to May 2017- NEPCT90 from Table XXIII

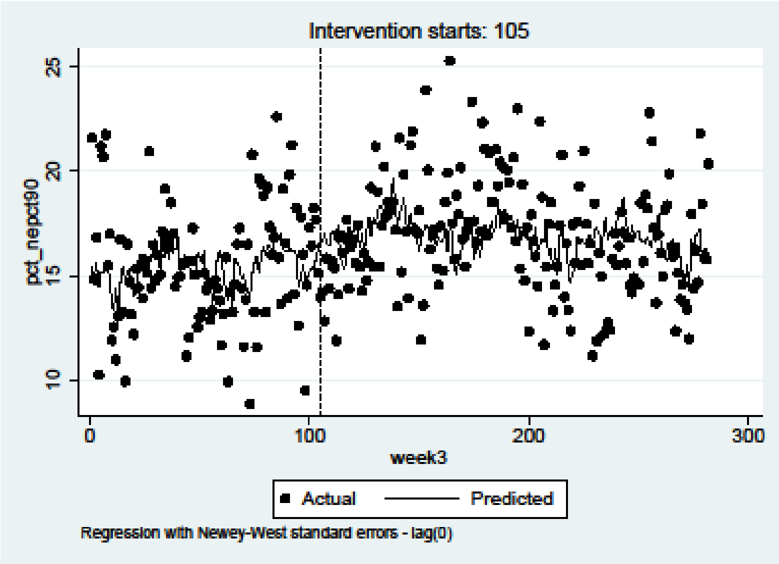
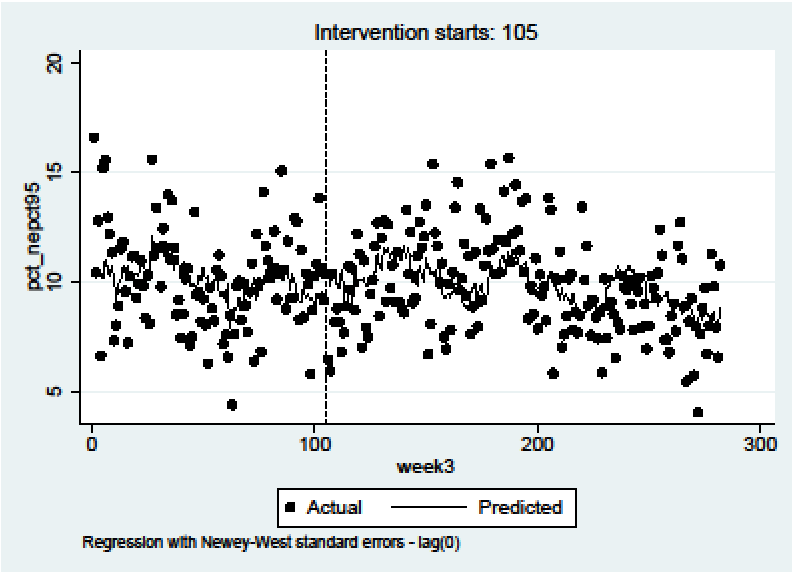


Figure 49. Actual and Predicted Values by Week for Proportion Non-Emergent + Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)-Medicaid Patients - January 2012 to May 2017- NEPCT95 from Table XXIII



APPENDIX C (continued)

Figure 50. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits by Continuous Mean (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)-Medicaid Patients - January 2012 to May 2017- NE from Table XXIV

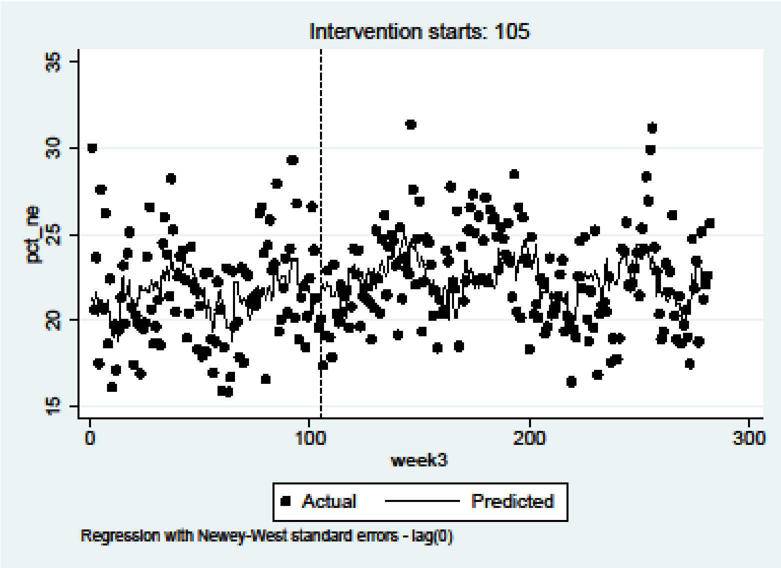
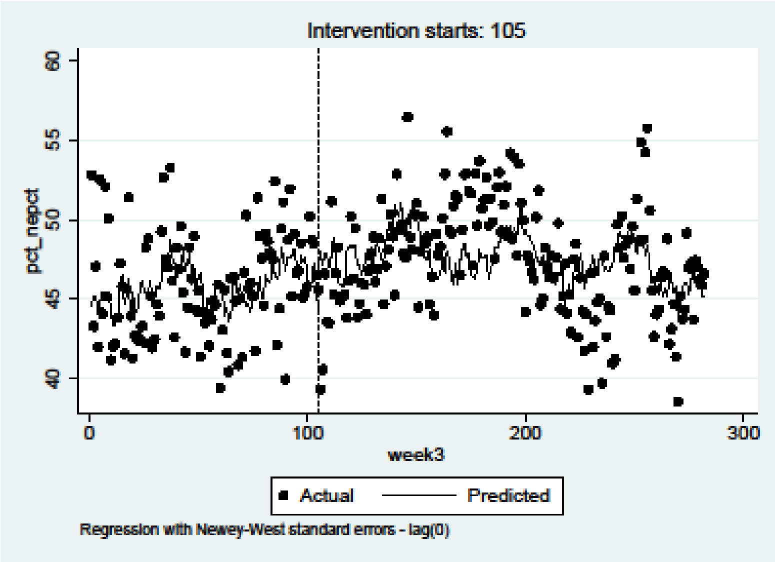


Figure 51. Actual and Predicted Values by Week for Proportion Non-Emergent + Primary Care Treatable Emergency Department Visits by Continuous Mean (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Medicaid Patients - January 2012 to May 2017- NEPCT from Table XXIV



APPENDIX C (continued)

Figure 52. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- NE50 from Table XXVI

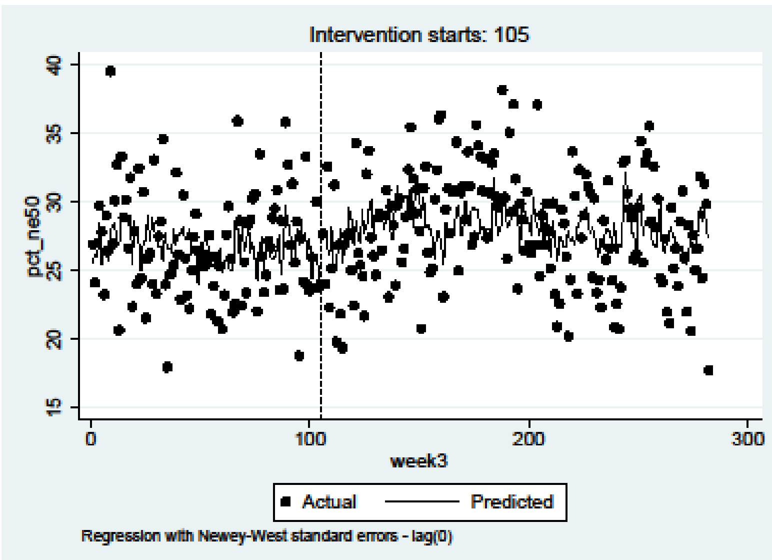
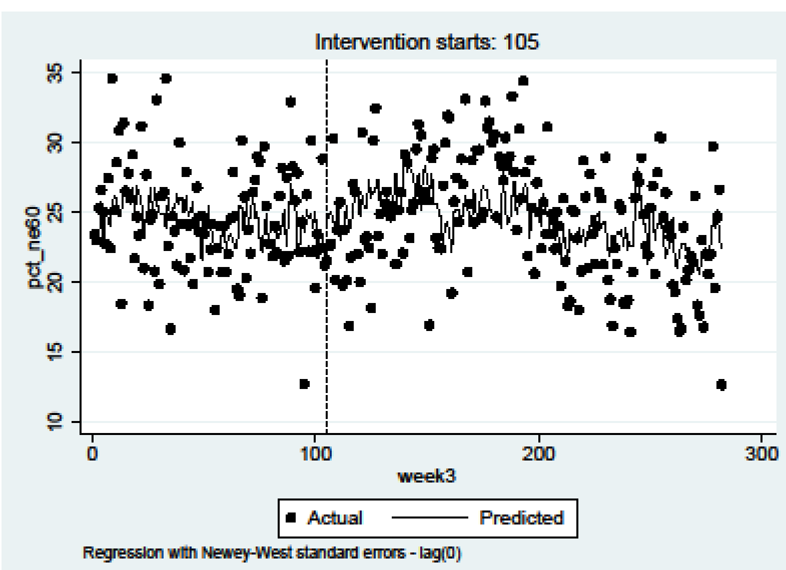


Figure 53. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- NE60 from Table XXVI



APPENDIX C (continued)

Figure 54. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- NE70 from Table XXVI

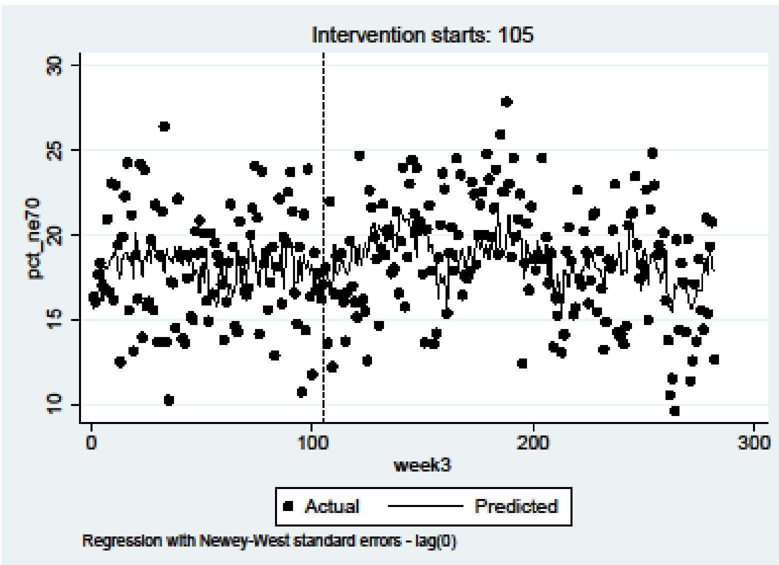
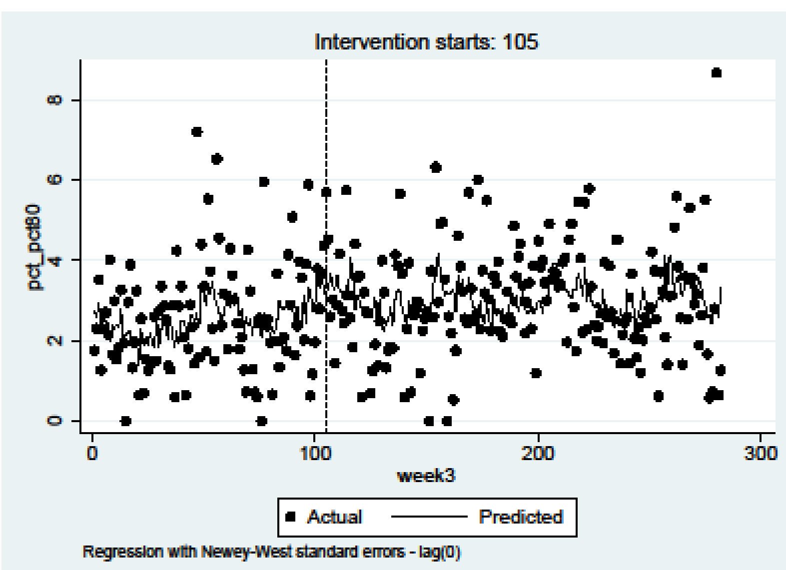


Figure 55. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- PCT80 from Table XXVI



APPENDIX C (continued)

Figure 56. Actual and Predicted Values by Week for Proportion Non-Emergent+Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- NEPCT50 from Table XXVI

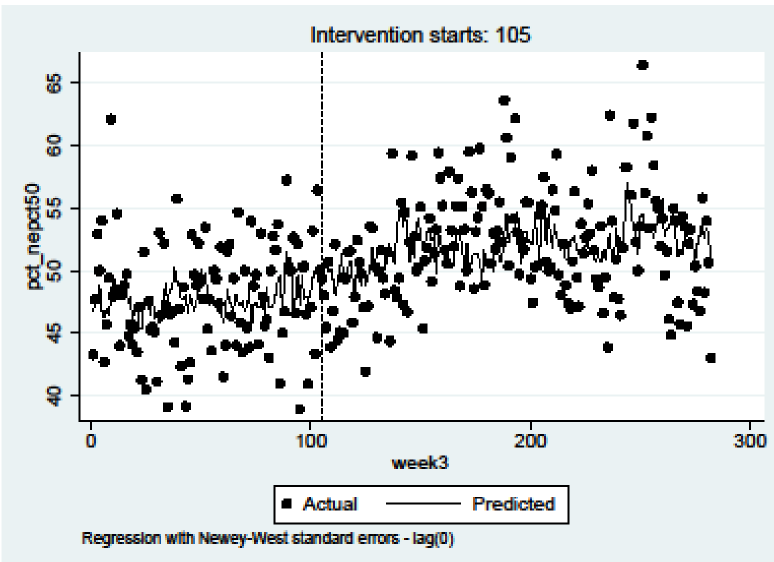
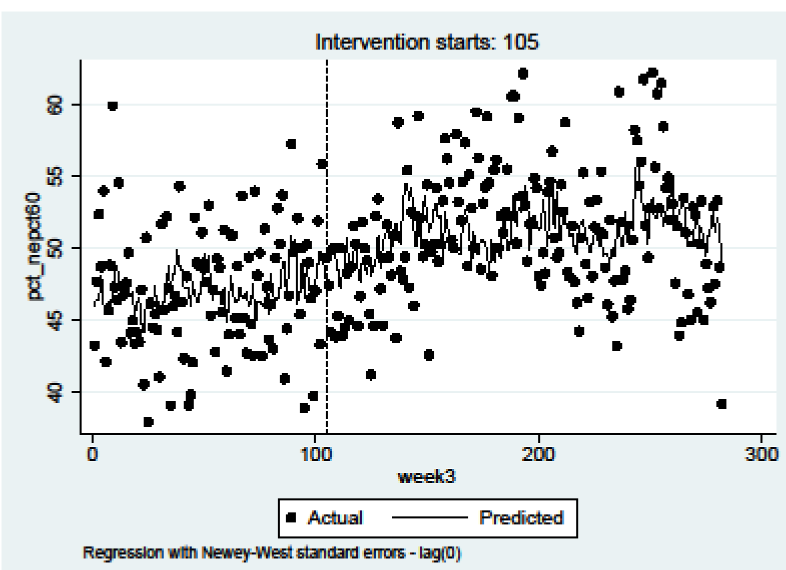


Figure 57. Actual and Predicted Values by Week for Proportion Non-Emergent+Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- NEPCT60 from Table XXVI



APPENDIX C (continued)

Figure 58. Actual and Predicted Values by Week for Proportion Non-Emergent+Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- NEPCT90 from Table XXVI

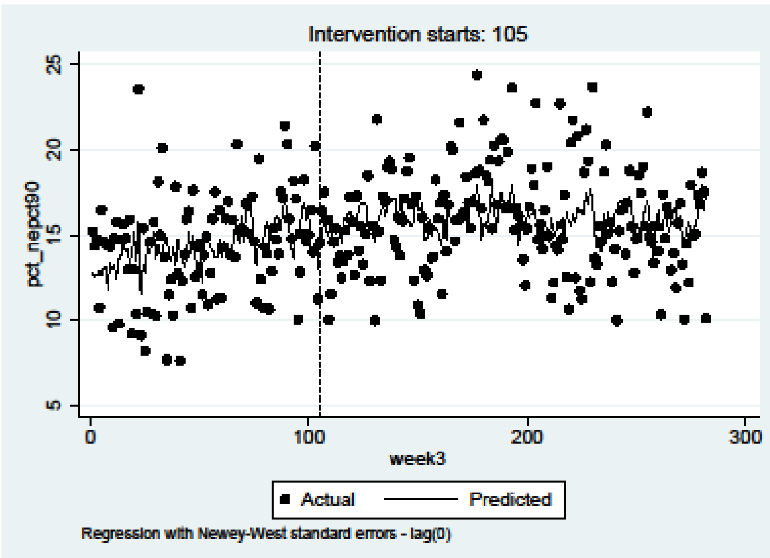
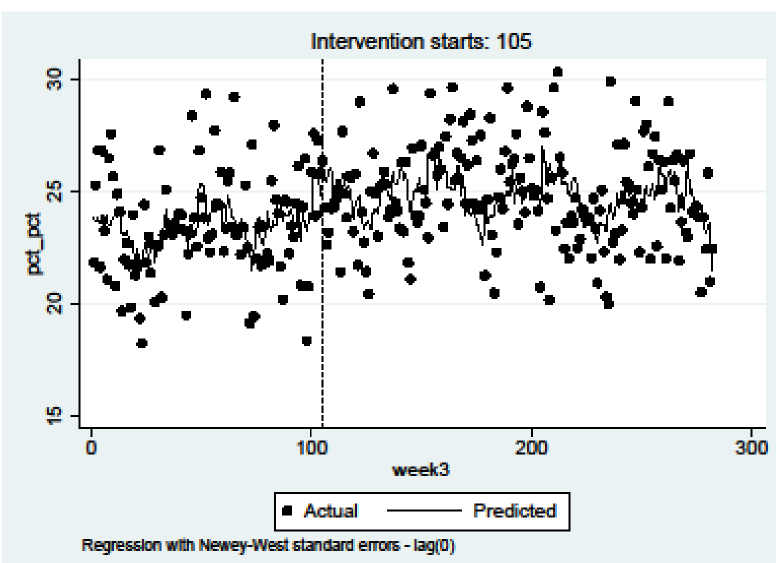


Figure 59. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits by Continuous Mean (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- PCT from Table XXVII



APPENDIX C (continued)

Figure 60. Actual and Predicted Values by Week for Proportion Non-Emergent + Primary Care Treatable Emergency Department Visits by Continuous Mean (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- NEPCT from Table XXVII

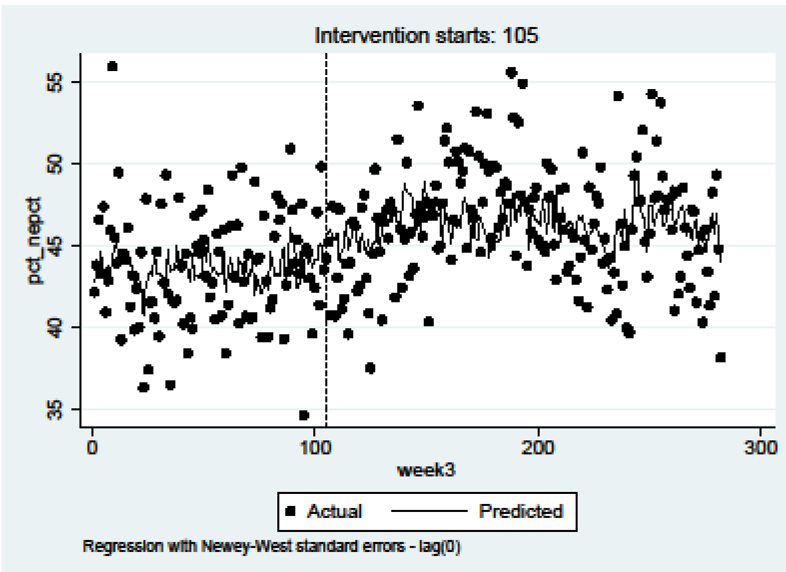
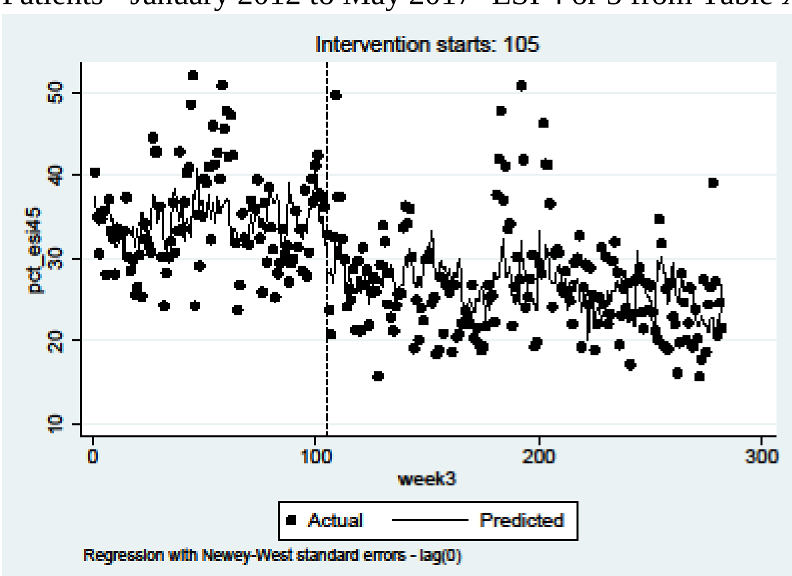


Figure 61. Actual and Predicted Values by Week for Proportion Emergency Department Visits Assigned Emergency Severity Index (ESI) 4 or 5 (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Private Insurance Patients - January 2012 to May 2017- ESI 4 or 5 from Table XXVIII



APPENDIX C (continued)

Figure 62. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Patients Who Arrived During Business Hours - January 2012 to May 2017- NE50 from Table XXIX

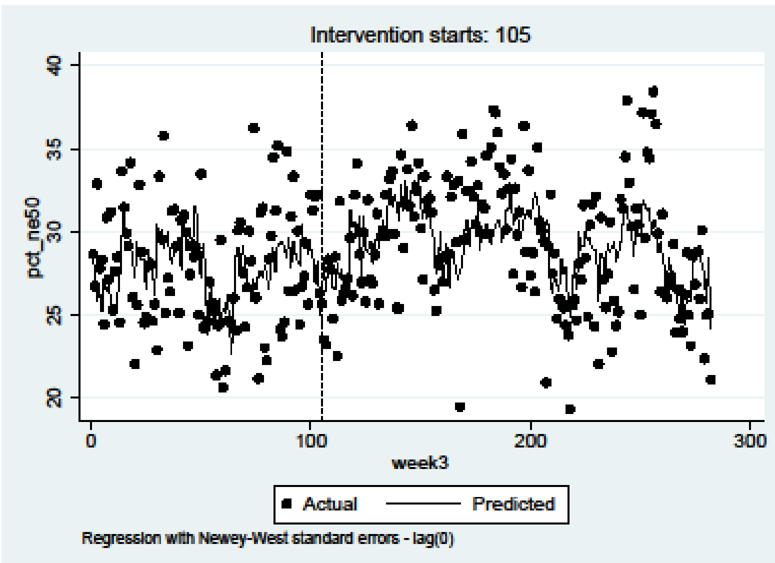
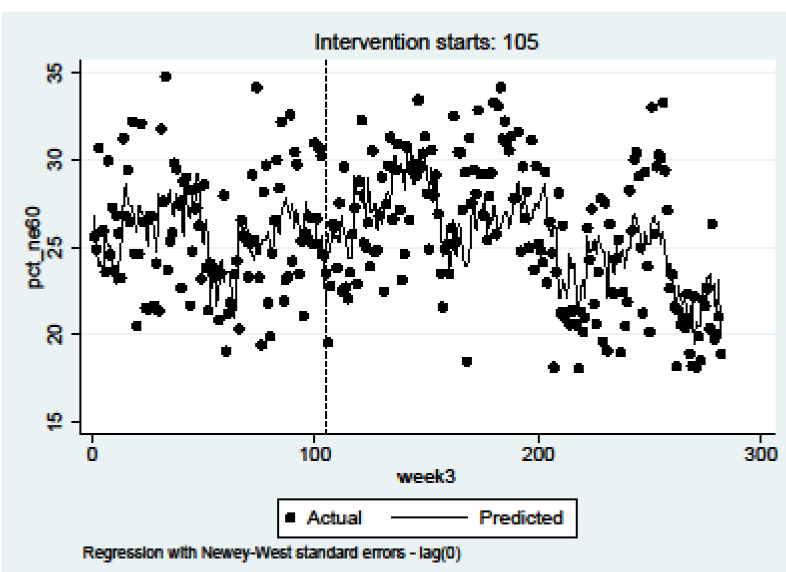


Figure 63. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Patients Who Arrived During Business Hours - January 2012 to May 2017- NE60 from Table XXIX



APPENDIX C (continued)

Figure 64. Actual and Predicted Values by Week for Proportion Non-Emergent Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Patients Who Arrived During Business Hours - January 2012 to May 2017- NE70 from Table XXIX

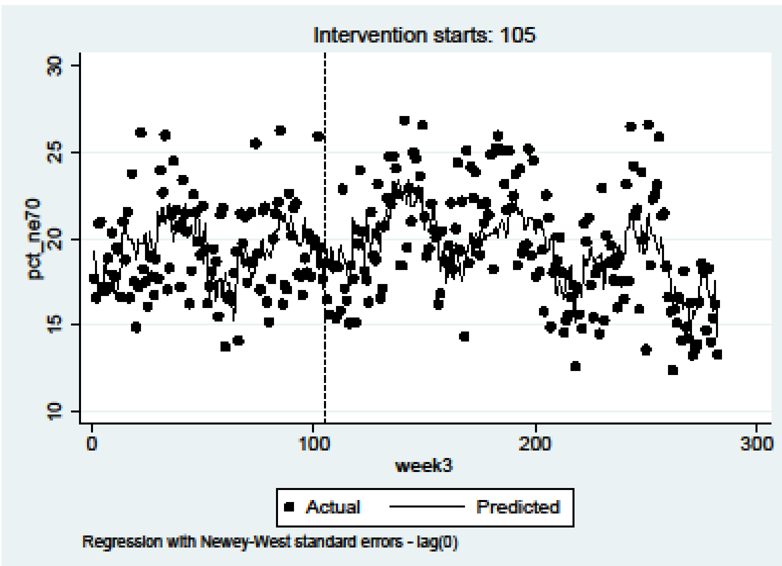
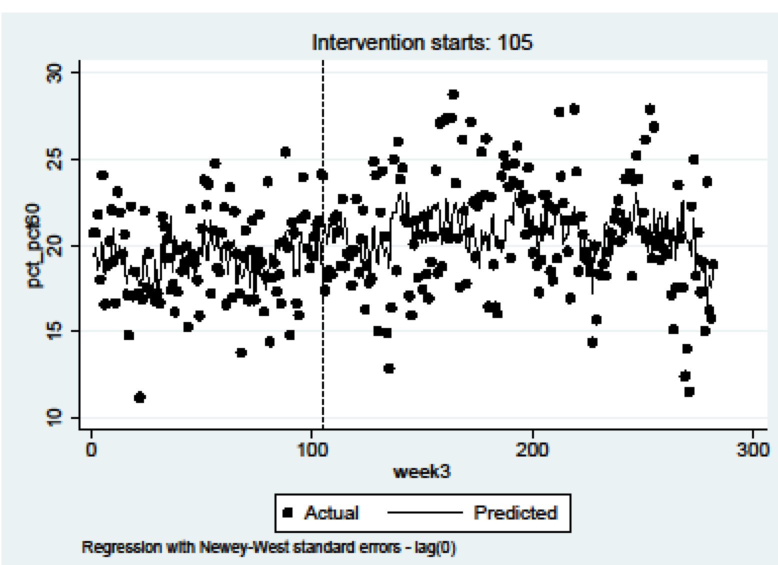


Figure 65. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Patients Who Arrived During Business Hours - January 2012 to May 2017- PCT60 from Table XXIX



APPENDIX C (continued)

Figure 66. Actual and Predicted Values by Week for Proportion Primary Care Treatable Emergency Department Visits by Continuous Mean (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Patients Who Arrived During Business Hours - January 2012 to May 2017- PCT from Table XXX

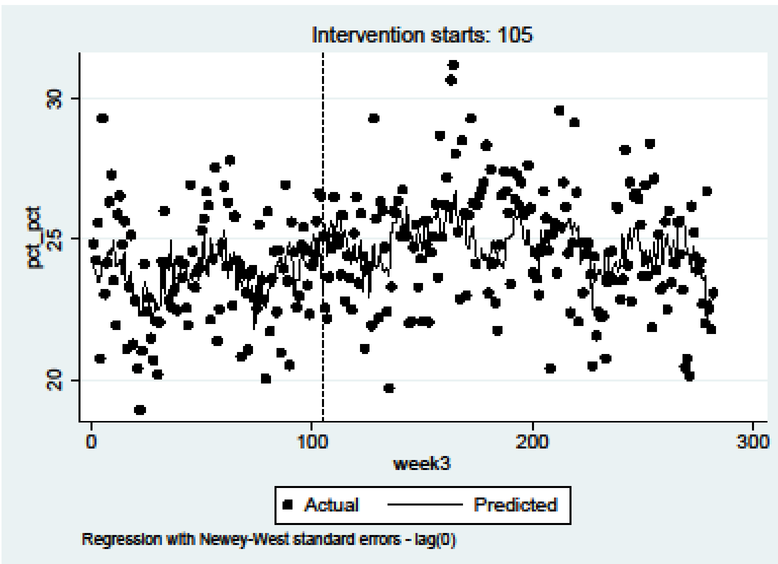
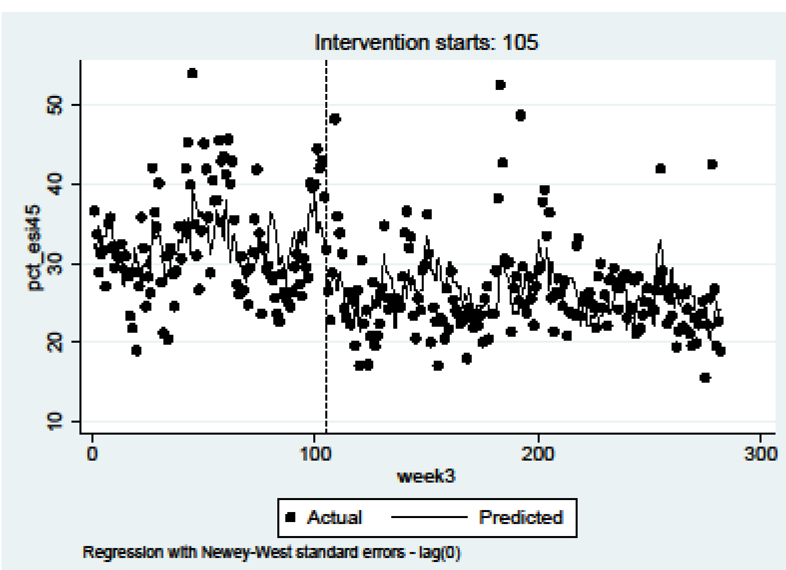


Figure 67. Actual and Predicted Values by Week for Proportion Emergency Department Visits Assigned Emergency Severity Index (ESI) 4 or 5 (%) at University of Illinois Hospital Surrounding Implementation of the Affordable Care Act (at Week 105)- Patients Who Arrived During Business Hours - January 2012 to May 2017- ESI 4 or 5 from Table XXXI



APPENDIX D

Initial Institutional Review Board Approval- Chapter I

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Exemption Granted

December 8, 2014

Terry Vanden Hoek, MD
Emergency Medicine
808 S. Wood Street
Dept. Emergency Medicine, M/C 724
Chicago, IL 60612
Phone: (312) 996-6560 / Fax: (312) 413-0289

RE: **Research Protocol # 2014-1066**
"A Quality Improvement Retrospective Chart Review of Frequent ED Visitors"

PAF#: None

Grant/Contract No: N/A
Grant/Contract Title: Innovative Health Care Strategy Award (IHSA)

Sponsors: Vice President of Health Affairs

Dear Terry Vanden Hoek:

Your Claim of Exemption was reviewed on December 3, 2014 and it was determined that you research meets the criteria for exemption. You may now begin your research

Exemption Period:	**December 3, 2014 – December 3, 2017**
Performance Site:	UIC
Subject Population:	Adult (18+ years) subjects only
Number of Subjects:	3600

Your research may be conducted at UIC and with Adults - Patients/Subjects, Mentally Disabled or Mentally Ill.

APPENDIX D (continued)

The specific exemption category under 45 CFR 46.101(b) is:
(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
11/04/2014	Initial Review	Exempt	11/12/2014	Modifications Required
11/24/2014	Response To Modifications	Exempt	12/03/2014	Approved

HIPAA Waiver:
The Board determined that this research meets the regulatory requirements for waiver of authorization as permitted at 45CFR164.512(i)(1)(i)(A). Specifically, that the use or disclosure of protected health information (PHI) meets the waiver criteria under 45CFR164.512(i)(2)(ii); the research involves no more than a minimal risk to the privacy of the individuals; the research could not practicably be conducted without the waiver; and the research could not practicably be conducted without access to and use of the PHI.

You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy. Please be aware of the following UIC policies and responsibilities for investigators:

1. <u>Amendments</u> You are responsible for reporting any amendments to your research protocol that may affect the determination of the exemption and may result in your research no longer being eligible for the exemption that has been granted.

2. <u>Record Keeping</u> You are responsible for maintaining a copy all research related records in a secure location in the event future verification is necessary, at a minimum these documents include: the research protocol, the claim of exemption application, all questionnaires, survey instruments, interview questions and/or data collection instruments associated with this research protocol, recruiting or advertising materials, any consent forms or information sheets given to subjects, or any other pertinent documents.

3. <u>Final Report</u> When you have completed work on your research protocol, you should submit a final report to the Office for Protection of Research Subjects (OPRS).

4. <u>Information for Human Subjects</u> UIC Policy requires investigators to provide information about the research protocol to subjects and to obtain their permission prior to their participating in the research. The information about the research protocol should be presented to subjects in writing or orally from a written script. <u>When appropriate</u>, the following information must be provided to all research subjects participating in exempt studies:

APPENDIX D (continued)

a. The researchers affiliation; UIC, JBVMAC or other institutions,
b. The purpose of the research,
c. The extent of the subject's involvement and an explanation of the procedures to be followed,
d. Whether the information being collected will be used for any purposes other than the proposed research,
e. A description of the procedures to protect the privacy of subjects and the confidentiality of the research information and data,
f. Description of any reasonable foreseeable risks,
g. Description of anticipated benefit,
h. A statement that participation is voluntary and subjects can refuse to participate or can stop at any time,
i. A statement that the researcher is available to answer any questions that the subject may have and which includes the name and phone number of the investigator(s).
j. A statement that the UIC IRB/OPRS or JBVMAC Patient Advocate Office is available if there are questions about subject's rights, which includes the appropriate phone numbers.

Please be sure to:

→ Use your research protocol number (2014-1066) on any documents or correspondence with the IRB concerning your research protocol.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact the OPRS office at (312) 996-1711 or me at (312) 355-2908. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Charles W. Hoehne, B.S.
Assistant Director, IRB # 2
Office for the Protection of Research Subjects

cc: Terry Vanden Hoek, Emergency Medicine, M/C 724

Privacy Office, Health Information Management Department, M/C 772

APPENDIX D (continued)

<u>Institutional Review Board Expedited Review Approval- Chapter I</u>

Approval Notice

Amendment to Research Protocol and/or Consent Document – Expedited Review

UIC Amendment #9

December 11, 2017

Sara Heinert, MPH

Emergency Medicine

808 S. Wood Street

M/C 724

Chicago, IL 60612

Phone: (312) 413-5504 / Fax: (312) 413-0289

RE: **Protocol # 2014-1066**
"A Quality Improvement Retrospective Chart Review of Frequent ED Visitors"

Dear Ms. Heinert:

Members of Institutional Review Board (IRB) #3 have reviewed this amendment to your research and/or consent form under expedited procedures for minor changes to previously approved research allowed by Federal regulations [45 CFR 46.110(b)(2)]. The amendment to your research was determined to be acceptable and may now be implemented.

Please note the following information about your approved amendment:

<u>UIC IRB Approval Period:</u> **December 11, 2017 – December 11, 2018**

<u>Amendment Approval Date:</u> December 11, 2017

<u>Amendment:</u>

Investigator's Summary: UIC Amendment #9, initially received November 16, 2017, involves the following:

APPENDIX D (continued)

1. Illinois state claims data will not be utilized for this project. Any mention of it within the application has been removed.
2. More information on the strategy for evaluating the program has been added- including collecting data on comparable ED utilizers who were not part of the program.
3. The previous version of the application underestimated the number of ED patients with 4 or more ED visits during the time period of interest. We have increased this number from 3600 to 4000.
4. We are interested in matching program participants and comparison patients on poverty level by census tract of home address. As a result, we will collect patient addresses to determine the patient's census tract and then the level of poverty for the census tract. The only information that will go into the study database will be the percent poverty for the patient's census tract.
5. Master coding list- Names will not be included on the master coding list. Any mention of it within the application has been removed. Also, we will include month of eligibility for comparison patients (those who have had 4 or more ED visits in the past 12 months from that month), and not date of service, on the master coding list.
6. The data collection period has been changed to January 1, 2012 through August 30, 2016. (The end date has changed from April 1, 2016 to August 30, 2016.) The data collection period has been extended so that we can look at longer term outcomes for the evaluation of the EPIC program. Extension to August 30, 2016 allows for examination of data 12 months after the end of the program. No additional patients will be added to the subject pool and the only variables that will be collected for this extended time period are our outcomes of interest: number of ED visits, number of inpatient visits, and number of outpatient visits.

Approved Subject Enrollment #: 4000

Performance Sites: UIC

Sponsor: None

Research Protocol(s):

a) QI EPIC Initiative. #2014-1066. Study Protocol. Heinert Version 6 12/06/2017

Recruiting Material(s): None

Informed Consent(s):

a) Waiver of Informed Consent granted under 45 CFR 46.116(d)

HIPAA Authorization(s):

The Board determined that this research meets the regulatory requirements for waiver of authorization as permitted at 45CFR164.512(i)(1)(i)(A). Specifically, that the use or disclosure of protected health information (PHI) meets the waiver criteria under 45CFR164.512(i)(2)(ii); the research involves no more than a minimal risk to the privacy of the individuals; the research could not practicably be conducted without the waiver; and the research could not practicably be conducted without access to and use of the PHI.

APPENDIX D (continued)

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
11/16/2017	Amendment	Expedited	12/05/2017	Modifications Required
12/06/2017	Response to Modifications	Expedited	12/11/2017	Approved

Please be sure to:

→ Use your research protocol number (2014-1066) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements as per,
"UIC Investigator Responsibilities, Protection of Human Research Subjects"
(*http://tigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf*)

Please note that the UIC IRB #3 has the right to ask further questions, seek additional information, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact the OPRS at (312) 996-1711 or me at (312) 355-2908.

Sincerely,

Charles W. Hoehne, B.S., C.I.P.

Assistant Director

Office for the Protection of Research Subjects

Enclosure(s): None

cc: Terry Vanden Hoek, Emergency Medicine, M/C 724
Privacy Office, Health Information Management Department, M/C 772

APPENDIX D (continued)

<u>Initial Institutional Review Board Approval- Chapters II and III</u>

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice

Initial Review (Response to Modifications)

September 28, 2015

Sara Heinert, MPH

Emergency Medicine

808 S. Wood Street

Emergency Department, M/C 724

Chicago, IL 60612

Phone: (312) 413-5504 / Fax: (312) 413-0289

RE: Protocol # 2015-0859

"The Relationship Between Availability of Community Health Resources and Emergency Department Utilization"

Dear Ms. Heinert:

Your Initial Review (Response to Modifications) was reviewed and approved by the Expedited review process on September 28, 2015. You may now begin your research.

APPENDIX D (continued)

Please note the following information about your approved research protocol:

Protocol Approval Period:	September 28, 2015 - September 27, 2016
Approved Subject Enrollment#:	19000
Performance Sites:	UIC
Sponsor:	None

Research Protocol:

a) The Relationship Between Availability of Community Health Resources and Emergency Department Utilization; Version 2, 9/1/15

Informed Consent:

a) Waiver of Informed Consent granted [45 CFR 46.116(d)].

HIPAA Authorization:

a) Waiver of Authorization granted [45 CFR 164.512(i)(1)(i)].

Additional Determinations for Research Involving Minors:

These determinations have not been made for this study since it has not been approved for enrollment of minors.

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category:

(5) Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis).

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
08/17/2015	Initial Review	Exempt	08/30/2015	Modifications Required
09/02/2015	Response To Modifications	Expedited	09/28/2015	Approved

APPENDIX D (continued)

Please remember to:

→ Use your **research protocol number** (#2015-0859) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,

"UIC Investigator Responsibilities, Protection of Human Research Subjects"
(*http://tigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf*)

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 413-3202. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Teresa D. Johnston, B.S., C.I.P.

Assistant Director

Office for the Protection of Research Subjects

Enclosures:

1. **UIC Investigator Responsibilities, Protection of Human Research Subjects**
2. **HIPAA Authorization:**
   a) Waiver of Authorization granted [45 CFR 164.512(i)(1)(i)].

cc: Terry Vanden Hoek, Emergency Medicine, M/C 724
Privacy Office, Health Information Management Department, M/C 772

APPENDIX D (continued)

Continuing Review #1 Institutional Review Board Approval- Chapters II and III

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice

Continuing Review (Response To Modifications)

September 26, 2016

Sara Heinert, MPH

Emergency Medicine

808 S. Wood Street

Emergency Department, M/C 724

Chicago, IL 60612

Phone: (312) 413-5504 / Fax: (312) 413-0289

RE: Protocol # 2015-0859

"The Relationship Between Availability of Community Health Resources and Emergency Department Utilization"

Dear Dr. Heinert:

Your Continuing Review (Response To Modifications) was reviewed and approved by the Expedited review process on September 20, 2016. You may now continue your research.

APPENDIX D (continued)

Please note the following information about your approved research protocol:

<u>Protocol Approval Period:</u> September 27, 2016 - September 27, 2017

<u>Approved Subject Enrollment #:</u> 50000 (0 Enrolled to Date)

<u>Additional Determinations for Research Involving Minors:</u> These determinations have not been made for this study since it has not been approved for enrollment of minors.

<u>Performance Sites:</u> UIC

<u>Sponsor:</u> None

<u>Research Protocol(s):</u>

b) The Relationship Between Availability of Community Health Resources and Emergency Department Utilization; Version 4, 12/9/15

<u>Informed Consent(s):</u>

b) Waiver of Informed Consent granted [45 CFR 46.116(d)].

<u>HIPAA Authorization(s):</u>

b) Waiver of Authorization granted [45 CFR 164.512(i)(1)(i)].

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category:

(5) Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis).

<u>Please note the Review History of this submission:</u>

Receipt Date	Submission Type	Review Process	Review Date	Review Action
08/24/2016	Continuing Review	Expedited	09/01/2016	Modifications Required
09/19/2016	Response To Modifications	Expedited	09/20/2016	Approved

APPENDIX D (continued)

Please remember to:

→ Use your **research protocol number** (2015-0859) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,

"UIC Investigator Responsibilities, Protection of Human Research Subjects"
(*http://tigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf*)

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-0865. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Camonie J. Johnson

IRB Coordinator, IRB # 1

Office for the Protection of Research Subjects

cc: Terry Vanden Hoek, Emergency Medicine, M/C 724

APPENDIX D (continued)

Continuing Review #2 Institutional Review Board Approval- Chapters II and III

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice

Continuing Review

****REVISED****

September 14, 2017

Sara Heinert, MPH

Emergency Medicine

808 S. Wood Street

Emergency Department, M/C 724

Chicago, IL 60612

Phone: (312) 413-5504 / Fax: (312) 413-0289

RE: Protocol # 2015-0859

"The Relationship Between Availability of Community Health Resources and Emergency Department Utilization"

Dear Dr. Heinert:

Your Continuing Review was reviewed and approved by the Expedited review process on September 13, 2017. You may now continue your research.

APPENDIX D (continued)

Please note the following information about your approved research protocol:

Protocol Approval Period: September 27, 2017 - September 27, 2018

Approved Subject Enrollment #: 360000 (354714 Enrolled to Date; ***Enrollment Closed)******

Additional Determinations for Research Involving Minors: The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk. ***Enrollment is closed.******

Performance Sites: UIC

Sponsor: None

PAF#:

Grant/Contract No:

Grant/Contract Title:

Research Protocol(s):

c) The Relationship Between Availability of Community Health Resources and Emergency Department Utilization; Version 7, 1/31/17

Informed Consent(s):

E. N/A; Enrollment Closed***

F. Assent(s):

G. N/A; Enrollment Closed***

Parental Permission(s):

a) N/A; Enrollment Closed***

HIPAA Authorization(s):

c) N/A; Enrollment Closed***

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category:

(5) Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis).

APPENDIX D (continued)

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
08/31/2017	Continuing Review	Expedited	09/13/2017	Approved

Please remember to:

→ Use your **research protocol number** (2015-0859) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,

"UIC Investigator Responsibilities, Protection of Human Research Subjects"
(http://tigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf)

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-0865. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Camonie J. Johnson

IRB Coordinator, IRB # 1

Office for the Protection of Research Subjects

cc: Terry Vanden Hoek, Emergency Medicine, M/C 724
Privacy Office, Health Information Management Department, M/C 772

CITED LITERATURE

Abadie, A. (2005). Semiparametric difference-in-differences estimators. *Review of Economic Studies, 72*(250), 1.

Abello, A., Brieger, B., Dear, K., King, B., Ziebell, C., Ahmed, A., & Milling, T. J. (2012). Care plan program reduces the number of visits for challenging psychiatric patients in the ED. *American Journal of Emergency Medicine, 30*(7), 1061. 10.1016/j.ajem.2011.07.002

Aday, L. (1994). Health status of vulnerable populations. *Annual Review of Public Health, 15*(1), 487-509. 10.1146/annurev.publhealth.15.1.487

Agency for Healthcare Research and Quality. (2014). Chapter 2. What is care coordination? Retrieved from http://www.ahrq.gov/professionals/prevention-chronic-care/improve/coordination/atlas2014/chapter2.html

Artiga, S. (2014). *Profiles of Medicaid outreach and enrollment strategies: The Cook County early expansion initiative.* The Kaiser Family Foundation. Retrieved from http://files.kff.org/attachment/profiles-of-medicaid-outreach-and-enrollment-strategies-the-cook-county-early-expansion-initiative-issue-brief

Artiga, S., Rudowitz, R., & Ranji, U. (2015). *How have state Medicaid expansion decisions affected the experience of low-income adults?; Perspectives from Ohio, Arkansas, and Missouri*. The Henry J. Kaiser Family Foundation. Retrieved from http://files.kff.org/attachment/issue-brief-how-have-state-medicaid-expansion-decisions-affected-the-experiences-of-low-income-adults-perspectives-from-ohio-arkansas-and-missouri

Austin, P. C. (2009). Balance diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched samples. *Statistics in Medicine, 28*(25), 3083-3107. 10.1002/sim.3697

Austin, P. C. (2011). An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behavioral Research, 46*(3), 399-424. 10.1080/00273171.2011.568786

Ballard, D.W., Price, M., Fung, V., Brand, R., Reed, M. E., Fireman, B., . . . Hsu, J. (2010). Validation of an algorithm for categorizing the severity of hospital emergency department visits. *Medical Care, 48*(1), 58-63. 10.1097/MLR.0b013e3181bd49ad

Barnett, J. C., & Vornovitsky, M. S. (2016). *Health insurance coverage in the United States: 2015.* Washington, DC: U.S. Government Printing Office.

Becker, S. O., & Ichino, A. (2002). Estimation of average treatment effects based on propensity scores. *Stata Journal, 2*(4), 358-377.

Behr, J. G., & Diaz, R. (2016). Emergency department frequent utilization for non-emergent presentments: Results from a regional urban trauma center study. *PloS One, 11*(1), e0147116. 10.1371/journal.pone.0147116

Bell, J. F., Krupski, A., Joesch, J. M., West, I. I., Atkins, D. C., Court, B., . . . Roy-Byrne, P. (2015). A randomized controlled trial of intensive care management for disabled medicaid beneficiaries with high health care costs. *Health Services Research, 50*(3), 663-689. 10.1111/1475-6773.12258

Billings, J., Parikh, N., & Mijanovich, T. (2000a). *Emergency department use in New York City: A substitute for primary care?* The Commonwealth Fund. Retrieved from https://www.commonwealthfund.org/sites/default/files/documents/___media_files_publications_issue_brief_2000_mar_emergency_department_use_in_new_york_city__a_substitute_for_primary_care_billings_eduse_433_pdf.pdf

Billings, J., Parikh, N., & Mijanovich, T. (2000b). *Emergency room use: The New York story.* The Commonwealth Fund. Retrieved from https://wagner.nyu.edu/files/admissions/Billings%20-%20Emergency%20Room%20Use%20-%20The%20New%20York%20Story.pdf

Billings, J., & Raven, M. C. (2013). Dispelling an urban legend: Frequent emergency department users have substantial burden of disease. *Health Affairs (Project Hope), 32*(12), 2099.

Brandon, W. R., & Chambers, R. (2003). Reducing emergency department visits among high-using patients. *The Journal of Family Practice, 52*(8), 637.

Bryson, A., Dorsett, R., & Purdon, S. (2002). *The use of propensity score matching in the evaluation of active labour market policies.* Department for Work and Pensions. Retrieved from http://eprints.lse.ac.uk/4993/

Byrne, M., Murphy, A. W., Plunkett, P. K., McGee, H. M., Murray, A., & Bury, G. (2003). Frequent attenders to an emergency department: A study of primary health care use, medical profile, and psychosocial characteristics. *Annals of Emergency Medicine, 41*(3), 309-318. 10.1067/mem.2003.68

Caliendo, M., & Kopeinig, S. (2008). Some practical guidance for the implementation of propensity score matching. *Journal of Economic Surveys, 22*(1), 31-72. 10.1111/j.1467-6419.2007.00527.x

Capp, R., Rooks, S., Wiler, J., Zane, R., & Ginde, A. (2014). National study of health insurance type and reasons for emergency department use. *Journal of General Internal Medicine, 29*(4), 621-627. 10.1007/s11606-013-2734-4

Capp, R., West, D. R., Doran, K., Sauaia, A., Wiler, J., Coolman, T., & Ginde, A. A. (2015). Characteristics of Medicaid-covered emergency department visits made by nonelderly adults: A national study. *The Journal of Emergency Medicine, 49*(6), 984-989. 10.1016/j.jemermed.2015.07.043

Chan, L., Hart, L. G., & Goodman, D. C. (2006). Geographic access to health care for rural Medicare beneficiaries. *The Journal of Rural Health, 22*(2), 140-146. 10.1111/j.1748-0361.2006.00022.x

Chen, B. K., Cheng, X., Bennett, K., & Hibbert, J. (2015). Travel distances, socioeconomic characteristics, and health disparities in nonurgent and frequent use of hospital emergency departments in South Carolina: A population-based observational study. *BMC Health Services Research*, *15*(1), 203. 10.1186/s12913-015-0864-6

Chen, C., Scheffler, G., & Chandra, A. (2011). Massachusetts' health care reform and emergency department utilization. *The New England Journal of Medicine, 365*(12), e25. 10.1056/NEJMp1109273

Colchero, M. A., Popkin, B. M., Rivera, J. A., & Ng, S. W. (2016). Beverage purchases from stores in Mexico under the excise tax on sugar sweetened beverages: Observational study. *Bmj, 352*, h6704. 10.1136/bmj.h6704

Committee on Energy & Commerce. Evaluating coordination of care in Medicaid: Improving quality and clinical outcomes: Subcommittee on Health, House of Representatives, One Hundred Eighth Congress, First session (2003). Retrieved from https://www.gpo.gov/fdsys/pkg/CHRG-108hhrg89962/pdf/CHRG-108hhrg89962.pdf

Cook, L. J., Knight, S., Junkins, E. P., Mann, N. C., Dean, J. M., & Olson, L. M. (2004). Repeat patients to the emergency department in a statewide database. *Academic Emergency Medicine, 11*(3), 256-263. 10.1111/j.1553-2712.2004.tb02206.x

Crane, S., Collins, L., Hall, J., Rochester, D., & Patch, S. (2012). Reducing utilization by uninsured frequent users of the emergency department: Combining case management and drop-in group medical appointments. *Journal of the American Board of Family Medicine : JABFM*, *25*(2), 184-191. 10.3122/jabfm.2012.02.110156

Cunningham, P. J. (2006). What accounts for differences in the use of hospital emergency departments across U.S. communities? *Health Affairs, 25*(5), w336. 10.1377/hlthaff.25.w324

Cunningham, P., & Sheng, Y. (2018). Trends in preventable inpatient and emergency department utilization in California between 2012 and 2015: The role of health insurance coverage and primary care supply. *Medical Care,* 10.1097/MLR.0000000000000851

Deaton, A., & Cartwright, N. (2017). Understanding and misunderstanding randomized controlled trials. *Social Science & Medicine,* S0277-9536(17)30735-9. 10.1016/j.socscimed.2017.12.005

DeHaven, M., Kitzman-Ulrich, H., Gimpel, N., Culica, D., O'Neil, L., Marcee, A., . . . Walton, J. (2012). The effects of a community-based partnership, project access dallas (PAD), on emergency department utilization and costs among the uninsured. *Journal of Public Health (Oxford, England), 34*(4), 577-583. 10.1093/pubmed/fds027

Dresden, S. M., Powell, E. S., Kang, R., McHugh, M., Cooper, A. J., & Feinglass, J. (2016). Increased emergency department use in Illinois after implementation of the Patient Protection and Affordable Care Act. *Annals of Emergency Medicine,* 10.1016/j.annemergmed.2016.06.026

eHealth. (2016). History and timeline of the Affordable Care Act (ACA). Retrieved from https://resources.ehealthinsurance.com/affordable-care-act/history-timeline-affordable-care-act-aca

Elmendorf, D. W. (2010). *Cost estimate: H.R. 4872, Reconciliation Act of 2010 (final health care legislation).* Washington, DC: Congressional Budget Office. Retrieved from http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/113xx/doc11379/amendreconprop.pdf

Enard, K. R., & Ganelin, D. M. (2013). Reducing preventable emergency department utilization and costs by using community health workers as patient navigators. *Journal of Healthcare Management / American College of Healthcare Executives, 58*(6), 412.

Fertig, A. R., Carlin, C. S., Ode, S. B., & Long, S. K. (2016). Pent-up demand after the Affordable Care Act. *Journal of Patient-Centered Research and Reviews, 3*(3), 209. 10.17294/2330-0698.1364

Finkelstein, A. N., Taubman, S. L., Allen, H. L., Wright, B. J., & Baicker, K. (2016). Effect of Medicaid coverage on ED use -- further evidence from Oregon's experiment. *The New England Journal of Medicine, 375*(16), 1505.

Fishman, J., McLafferty, S., & Galanter, W. (2016). Does spatial access to primary care affect emergency department utilization for nonemergent conditions? *Health Services Research,* 10.1111/1475-6773.12617

Frost, P., & Frellick, M. (2014, April 26). Illinois medicaid moves to managed care. *Chicago Tribune.* Retrieved from http://www.chicagotribune.com/lifestyles/health/ct-managed-care-medicaid-aca-met-20140427-story.html

Fuda, K. K., & Immekus, R. (2006). Frequent users of massachusetts emergency departments: A statewide analysis. *Annals of Emergency Medicine, 48*(1), 16.e8. 10.1016/j.annemergmed.2006.03.001

Gandhi, S. O., Grant, L. P., & Sabik, L. M. (2014). Trends in nonemergent use of emergency departments by health insurance status. *Medical Care Research and Review, 71*(5), 496-521. 10.1177/1077558714541481

Garthwaite, C., Gross, T., Notowidigdo, M., & Graves, J. A. (2017). Insurance expansion and hospital emergency department access: Evidence from the Affordable Care Act. *Annals of Internal Medicine, 166*(3), 172. 10.7326/M16-0086 Retrieved from https://search.proquest.com/docview/1867115720

Gertler, P. J., Martinez, S., Premand, P., Rawlings, L. B., & Vermeersch, C. M. J. (2011). *Impact evaluation in practice*. Washington, D.C: World Bank.

Gilboy, N., Tanabe, P., Travers, D., & Rosenau, A. M. (2012). *Emergency severity index (ESI): A triage tool for emergency department care.* Agency for Healthcare Research and Quality.

Gindi, R. M., Black, L. I., & Cohen, R. A. (2016). Reasons for emergency room use among U.S. adults aged 18-64: National health interview survey, 2013 and 2014. *National Health Statistics Reports,* (90), 1. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/26905514

Gray, J., Zink, A., & Dreyfus, T. (2016). *Effects of the Affordable Care Act through 2015*. Retrieved from https://www.athenahealth.com/~/media/athenaweb/files/pdf/acaview_tracking_the_impact_of_health_care_reform

Griffey, R. T., Pines, J. M., Farley, H. L., Phelan, M. P., Beach, C., Schuur, J. D., & Venkatesh, A. K. (2015). Chief complaint-based performance measures: A new focus for acute care quality measurement. *Annals of Emergency Medicine, 65*(4), 387-395. 10.1016/j.annemergmed.2014.07.453

Grover, C. A., Close, R. J., Villarreal, K., & Goldman, L. M. (2010). Emergency department frequent user: Pilot study of intensive case management to reduce visits and computed tomography. *The Western Journal of Emergency Medicine, 11*(4), 336-343.

Haas, S. W., Travers, D., Tintinalli, J. E., Pollock, D., Waller, A., Barthell, E., . . . McClay, J. (2008). Toward vocabulary control for chief complaint. *Academic Emergency Medicine, 15*(5), 476-482. 10.1111/j.1553-2712.2008.00104.x

Health Resources & Services Administration. 2016 Illinois health center data. Retrieved from https://bphc.hrsa.gov/uds/datacenter.aspx?year=2016&state=IL

Howard, M. S., Davis, B. A., Anderson, C., Cherry, D., Koller, P., & Shelton, D. (2005). Patients' perspective on choosing the emergency department for nonurgent medical care: A qualitative study exploring one reason for overcrowding. *Journal of Emergency Nursing, 31*(5), 429-435. 10.1016/j.jen.2005.06.023

Heckman, J. J., & Robb, R. (1985). Alternative methods for evaluating the impact of interventions. *Journal of Econometrics, 30*(1), 239-267. 10.1016/0304-4076(85)90139-3

Heckman, J. J. (1997). Matching as an econometric evaluation estimator. *The Review of Economic Studies, 64*(4), 605-654.

Heckman, J. J., Lalonde, R. J., & Smith, J. A. (1999). Chapter 31 the economics and econometrics of active labor market programs. *Handbook of labor economics* (pp. 1865-2097) Elsevier B.V.10.1016/S1573-4463(99)03012-6

Hunt, K. A., Weber, E. J., Showstack, J. A., Colby, D. C., & Callaham, M. L. (2006). Characteristics of frequent users of emergency departments. *Annals of Emergency Medicine, 48*(1), 1-8. 10.1016/j.annemergmed.2005.12.030

Illinois Comprehensive Health Insurance Plan. (2015). Illinois comprehensive insurance plan. Retrieved from http://www.chip.state.il.us

Illinois Department of Human Services. PM 20-03-04-a: Customer copays. Retrieved from http://www.dhs.state.il.us/page.aspx?item=17633

Jiang, J., Weiss, A., & Barrett, M. (2017). *Characteristics of emergency department visits for super-utilizers by payer, 2014. the HCUP report : Healthcare cost and utilization project (HCUP): Statistical briefs;2017 ASI 4186-20.221;statistical brief no. 221*.

Kangovi, S., Barg, F. K., Carter, T., Long, J. A., Shannon, R., & Grande, D. (2013). Understanding why patients of low socioeconomic status prefer hospitals over ambulatory care. *Health Affairs, 32*(7), 1196-1203. 10.1377/hltaff.2012.0825

Kanzaria, H. K., Niedzwiecki, M. J., Montoy, J. C., Raven, M. C. & Hsia, R. Y. (2017). Persistent frequent emergency department use: Core group exhibits extreme levels of use for more than A decade. *Health Affairs, 36*(10), 1720-1728. 10.1377/hlthaff.2017.0658

Klein, E. Y., Levin, S., Toerper, M. F., Mokowsky, M. D., Xu, T., Cole, G., & Kelen, G. D. (2017). The effect of Medicaid expansion on utilization in Maryland emergency departments. *Annals of Emergency Medicine, 70*(5), 607. 10.1016/j.annemergmed.2017.06.021

Koziol-McLain, J., Price, D. W., Weiss, B., Quinn, A. A., & Honigman, B. (2000). Seeking care for nonurgent medical conditions in the emergency department: Through the eyes of the patient. *Journal of Emergency Nursing, 26*(6), 554-563. 10.1067/men.2000.110904

LaCalle, E. (2010). Frequent users of emergency departments: The myths, the data, and the policy implications. *Ann Emerg Med, 56*(1), 42-48. 10.1016/j.annemergmed.2010.01.032

Lanzkron, S., Carroll, C. P., & Haywood, J., Carlton. (2010). The burden of emergency department use for sickle-cell disease: An analysis of the national emergency department sample database. *American Journal of Hematology, 85*(10), 797-799. 10.1002/ajh.21807

Lechner, M. (1999). Earnings and employment effects of continuous gff-the-job training in east germany after unification. *Journal of Business & Economic Statistics, 17*(1), 74-90. 10.1080/07350015.1999.10524798

Lee, D. C., Doran, K. M., Polsky, D., Cordova, E., & Carr, B. G. (2016). Geographic variation in the demand for emergency care: A local population-level analysis. *Healthcare, 4*(2), 98-103. 10.1016/j.hjdsi.2015.05.003

Lee, J., Ding, R., Zeger, S., McDermott, A., Habteh-Yimer, G., Chin, M., . . . McCarthy, M. (2015). Impact of subsidized health insurance coverage on emergency department utilization by low-income adults in Massachusetts. *Medical Care, 53*(1), 38-44. 10.1097/MLR.0000000000000279

Lee, K., & Davenport, L. (2006). Can case management interventions reduce the number of emergency department visits by frequent users? *The Health Care Manager, 25*(2), 155.

Linden, A. (2017). Challenges to validity in single-group interrupted time series analysis. *Journal of Evaluation in Clinical Practice, 23*(2), 413-418. 10.1111/jep.12638

Lo, N., Roby, D. H., Padilla, J., Chen, X., Salce, E. N., Pourat, N., & Kominski, G. F. (2014). Increased service use following Medicaid expansion is mostly temporary: Evidence from California's low income health program. *Policy Brief (UCLA Center for Health Policy Research),* (PB2014-7), 1. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/25376061

Lowe, R. A., Fu, R., Ong, E. T., McGinnis, P. B., Fagnan, L. J., Vuckovic, N., & Gallia, C. (2009). Community characteristics affecting emergency department use by Medicaid enrollees. *Medical Care, 47*(1), 15-22. 10.1097/MLR.0b013e3181844e1c

Mandelberg, J. H., Kuhn, R. E., & Kohn, M. A. (2000). Epidemiologic analysis of an urban, public emergency department's frequent users. *Academic Emergency Medicine, 7*(6), 637-646. 10.1111/j.1553-2712.2000.tb02037.x

Mathison, D. J., Chamberlain, J. M., Cowan, N. M., Engstrom, R. N., Fu, L. Y., Shoo, A., & Teach, S. J. (2013). Primary care spatial density and nonurgent emergency department utilization: A new methodology for evaluating access to care. *Academic Pediatrics, 13*(3), 278-285. 10.1016/j.acap.2013.02.006

McCormack, L. A. Jones, S. G., & Coulter, S. L. (2017). Demographic factors influencing nonurgent emergency department utilization among a Medicaid population. *Health Care Management Science, 395*(20). https://doi.org/10.1007/s10729-016-9360-8

McCormack, R. P., Hoffman, L. F., Wall, S. P., & Goldfrank, L. R. (2013). Resource-limited, collaborative pilot intervention for chronically homeless, alcohol-dependent frequent emergency department users. *American Journal of Public Health, 103 Suppl 2*(S2), S224. 10.2105/AJPH.2013.301373

Miller, S. (2012). The effect of insurance on emergency room visits: An analysis of the 2006 Massachusetts health reform. *Journal of Public Economics, 96*(11-12), 893-908. 10.1016/j.jpubeco.2012.07.004

Miller, S., & Wherry, L. R. (2017). Health and access to care during the first 2 years of the ACA Medicaid expansions. *The New England Journal of Medicine, 376*(10), 947.

Mobley, L. R., Root, E., Anselin, L., Lozano-Gracia, N., & Koschinsky, J. (2006). Spatial analysis of elderly access to primary care services. *International Journal of Health Geographics*, *5*(1), 19. 10.1186/1476-072X-5-19

National Association of Community Health Centers. (2015). *The role of health centers in lowering preventable emergency department use (fact sheet #0715).* Retrieved from http://nachc.org/wp-content/uploads/2015/06/ED_FS_20151.pdf

National Association of Community Health Centers. (2016). *Illinois health center fact sheet.* Retrieved from http://nachc.org/wp-content/uploads/2016/03/IL16.pdf

Navratil-Strawn, J. L., Hawkins, K., Wells, T. S., Ozminkowski, R. J., Hartley, S. K., Migliori, R. J., & Yeh, C. S. (2014). An emergency room decision-support program that increased physician office visits, decreased emergency room visits, and saved money. *Population Health Management, 17*(5), 257-264. 10.1089/pop.2013.0117

Newton, A., Sarker, S. J., Parfitt, A., Henderson, K., Jaye, P., & Drake, N. (2011). Individual care plans can reduce hospital admission rate for patients who frequently attend the emergency department. *Emergency Medicine Journal : EMJ, 28*(8), 654-657. 10.1136/emj.2009.085704

Nikpay, S., Freedman, S., Levy, H., & Buchmueller, T. (2017). Effect of the Affordable Care Act Medicaid expansion on emergency department visits: Evidence from state-level emergency department databases. *Annals of Emergency Medicine, 70*(2), 215. 10.1016/j.annemergmed.2017.03.023

Niska, R., Bhuiya, F., & Xu, J. (2010). National hospital ambulatory medical care survey: 2007 emergency department summary. *National Health Statistics Reports,* (26), 1. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20726217

Normand, S. T., Landrum, M. B., Guadagnoli, E., Ayanian, J. Z., Ryan, T. J., Cleary, P. D., & McNeil, B. J. (2001). Validating recommendations for coronary angiography following acute myocardial infarction in the elderly:A matched analysis using propensity scores. *Journal of Clinical Epidemiology, 54*(4), 387-398. 10.1016/S0895-4356(00)00321-8

Norris, L. (2017). Illinois and the ACA’s Medicaid expansion. Retrieved from https://www.healthinsurance.org/illinois-medicaid/

O’Neill, S., Kreif, N., Grieve, R., Sutton, M., & Sekhon, J. (2016). Estimating causal effects: Considering three alternatives to difference-in-differences estimation. *Health Services and Outcomes Research Methodology, 16*(1), 1-21. 10.1007/s10742-016-0146-8

Okin, R. L., Boccellari, A., Azocar, F., Shumway, M., O'Brien, K., Gelb, A., . . . Wachsmuth, C. (2000). The effects of clinical case management on hospital service use among ED frequent users. *American Journal of Emergency Medicine, 18*(5), 603-608. 10.1053/ajem.2000.9292

Penfold, R. B., & Zhang, F. (2013). Use of interrupted time series analysis in evaluating health care quality improvements. *Academic Pediatrics, 13*(6 Suppl), S38.

Peppe, E. M., Mays, J. W., Chang, H. C., Becker, E., & DiJulio, B. (2007). *Characteristics of frequent emergency department users*.The Henry J. Kaiser Family Foundation. Retrieved from https://kaiserfamilyfoundation.files.wordpress.com/2013/01/7696.pdf

Pillow, M. T., Doctor, S., Brown, S., Carter, K., & Mulliken, R. (2013). An emergency department-initiated, web-based, multidisciplinary approach to decreasing emergency department visits by the top frequent visitors using patient care plans. *The Journal of Emergency Medicine, 44*(4), 853-860. 10.1016/j.jemermed.2012.08.020

Pines, J. M., Zocchi, M., Moghtaderi, A., Black, B., Farmer, S. A., Hufstetler, G., . . . Pilgrim, R. (2016). Medicaid expansion in 2014 did not increase emergency department use but did change insurance payer mix. *Health Affairs (Project Hope), 35*(8), 1480-1486. 10.1377/hlthaff.2015.1632

Pitts, S. R., Pines, J. M., Handrigan, M. T., & Kellermann, A. L. (2012). National trends in emergency department occupancy, 2001 to 2008: Effect of inpatient admissions versus emergency department practice intensity. *Annals of Emergency Medicine, 60*(6), 679. 10.1016/j.annemergmed.2012.05.014

Pugh, L., Duffy, L., & Stauss, M. (2010). Patient care plans: An innovative approach to superusers in the emergency department. *Journal of Emergency Nursing, 36*(4), 344-346. 10.1016/j.jen.2010.02.017

Raven, M. C., Doran, K. M., Kostrowski, S., Gillespie, C. C., & Elbel, B. D. (2011). An intervention to improve care and reduce costs for high-risk patients with frequent hospital admissions: A pilot study. *BMC Health Services Research, 11*(1), 270. 10.1186/1472-6963-11-270

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika, 70*(1), 41. 10.2307/2335942

Rubin, D. B. & Thomas, N. (1996). Matching using estimated propensity scores: Relating theory to practice. *Biometrics, 52*(1), 249-264.

Rui, P., Kang, K., & Albert, M. (2016). *National hospital ambulatory medical care survey: 2013 emergency department summary tables.* Retrieved from https://www.cdc.gov/nchs/data/ahcd/nhamcs_emergency/2013_ed_web_tables.pdf

Rui, P., & Kang, K. (2017). *National hospital ambulatory medical care survey: 2015 emergency department summary tables.* Retrieved from https://www.cdc.gov/nchs/data/nhamcs/web_tables/2015_ed_web_tables.pdf

Rui, P., Hing, E., & Okeyode, T. (2017). *National ambulatory medical care survey: 2014 state and national summary tables.* Retrieved from https://www.cdc.gov/nchs/data/ahcd/namcs_summary/2014_namcs_web_tables.pdf

Rui, P., & Okeyode, T. (2017). *National ambulatory medical care survey: 2015 state and national summary tables.* Retrieved from https://www.cdc.gov/nchs/data/ahcd/namcs_summary/2015_namcs_web_tables.pdf

Sadowski, L. S., Kee, R. A., VanderWeele, T. J., & Buchanan, D. (2009). Effect of a housing and case management program on emergency department visits and hospitalizations among chronically ill homeless adults: A randomized trial. *Jama, 301*(17), 1771-1778. 10.1001/jama.2009.561

Saloner, B., Kenney, G. M., Polsky, D., Rhodes, K., Wissoker, D. A., & Zuckerman, S. (2014). *The availability of new patient appointments for primary care at federally qualified health centers: Findings from an audit study.* Urban Institute. Retrieved from http://gateway.proquest.com/openurl?url_ver=Z39.88-2004&res_dat=xri:policyfile&rft_dat=xri:policyfile:article:00166496

Sandoval, E., Smith, S., Walter, J., Schuman, S. H., Olson, M. P., Striefler, R., . . . Hickner, J. (2010). A comparison of frequent and infrequent visitors to an urban emergency department. *Journal of Emergency Medicine, 38*(2), 115-121. 10.1016/j.jemermed.2007.09.042

Sarver, J. H., Cydulka, R. K., & Baker, D. W. (2002). Usual source of care and nonurgent emergency department use. *Academic Emergency Medicine, 9*(9), 916-923. 10.1111/j.1553-2712.2002.tb02193.x

Seaberg, D., Elseroad, S., Dumas, M., Mendiratta, S., Whittle, J., Hyatte, C., . . . Mitchell, A. M. (2017). Patient navigation for patients frequently visiting the emergency department: A randomized, controlled trial. *Academic Emergency Medicine, 24*(11), 1327-1333. 10.1111/acem.13280

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston [u.a.]: Houghton Mifflin.

Shah, R., Chen, C., O'Rourke, S., Lee, M., Mohanty, S., & Abraham, J. (2011). Evaluation of care management for the uninsured. *Medical Care, 49*(2), 166-171. 10.1097/MLR.0b013e3182028e81

Shankar, S. M., Arbogast, P. G., Mitchel, E., Cooper, W. O., Wang, W. C., & Griffin, M. R. (2005). Medical care utilization and mortality in sickle cell disease: A population-based study. *American Journal of Hematology, 80*(4), 262-270. 10.1002/ajh.20485

Sharma, A. I., Dresden, S. M., Powell, E. S., Kang, R., & Feinglass, J. (2016). Emergency department visits and hospitalizations for the uninsured in Illinois before and after Affordable Care Act insurance expansion. *Journal of Community Health*, 10.1007/s10900-016-0293-4

Shartzer, A., Long, S. K., & Anderson, N. (2016). Access to care and affordability have improved following Affordable Care Act implementation; Problems remain. *Health Affairs (Project Hope), 35*(1), 161. 10.1377/hlthaff.2015.0755

Shin, P., Bruen, B., Jones, E., Ku, L., & Rosenbaum, S. (2010). *The economic stimulus: Gauging the early effects of ARRA funding on health centers and medically underserved populations and communities.* Geiger Gibson/RCHN Community Health Foundation Research Collaborative. Retrieved from http://hsrc.himmelfarb.gwu.edu/cgi/viewcontent.cgi?article=1005&context=sphhs_policy_ggrchn

Simon, K. (2016). Early impacts of the Affordable Care Act. *NBER Reporter, 2016*(1), 10.

Smith-Campbell, B. (2005). Emergency department and community health center visits and costs in an uninsured population. *Journal of Nursing Scholarship, 37*(1), 80-86. 10.1111/j.1547-5069.2005.00011.x

Smulowitz, P. B., O'Malley, J., Yang, X., & Landon, B. E. (2014). Increased use of the emergency department after health care reform in Massachusetts. *Annals of Emergency Medicine, 64*(2), 107. 10.1016/j.annemergmed.2014.02.011

Sommers, B. D., Gunja, M. Z., Finegold, K., & Musco, T. (2015). Changes in self-reported insurance coverage, access to care, and health under the Affordable Care Act. *Jama, 314*(4), 366-374. 10.1001/jama.2015.8421

Sommers, B. D., Blendon, R. J., Orav, E.J. & Epstein, A. M. (2016). Changes in utilization and health among low-income adults after Medicaid expansion or expanded private insurance. *JAMA Internal Medicine, 176*(10), 1501.

Sommers, B. D., Maylone, B., Blendon, R. J., Orav, E. J., & Epstein, A. M. (2017). Three-year impacts of the Affordable Care Act: Improved medical care and health among low-income adults. *Health Affairs, 36*(6), 1119. 10.1377/hlthaff.2017.0293

Spillane, L. L., Lumb, E. W., Cobaugh, D. J., Wilcox, S. R., Clark, J. S., & Schneider, S. M. (1997). Frequent users of the emergency department: Can we intervene? *Academic Emergency Medicine : Official Journal of the Society for Academic Emergency Medicine, 4*(6), 574-580. 10.1111/j.1553-2712.1997.tb03581.x

State of Illinois. (2018). Summary of benefits and coverage: What this plan covers & what you pay for covered services: STATE OF ILLINOIS: Aetna choice® POS II - OAP state. Retrieved from https://www2.illinois.gov/cms/benefits/StateEmployee/Documents/FY2018%20BC/FY18%20Aetna%20OAP%20SBC%20State.pdf

Stokes-Buzzelli, S., Peltzer-Jones, J. M., Martin, G. B., Ford, M. M., & Weise, A. (2010). Use of health information technology to manage frequently presenting emergency department patients. *The Western Journal of Emergency Medicine, 11*(4), 348-353.

Stuart, E., Huskamp, H., Duckworth, K., Simmons, J., Song, Z., Chernew, M., & Barry, C. (2014). Using propensity scores in difference-in-differences models to estimate the effects of a policy change. *Health Services and Outcomes Research Methodology, 14*(4), 166-182. 10.1007/s10742-014-0123-z

Sun, B. C., Burstin, H. R., & Brennan, T. A. (2003). Predictors and outcomes of frequent emergency department users. *Academic Emergency Medicine, 10*(4), 320-328. 10.1111/j.1553-2712.2003.tb01344.x

Taubman, S. L., Allen, H. L., Wright, B. J., Baicker, K., & Finkelstein, A. N. (2014). Medicaid increases emergency department use: Evidence from Oregon's health insurance experiment. *Science,* 10.1056/NEJM199603073341007

Vinton, D. T., Capp, R., Rooks, S. P., Abbott, J. T., & Ginde, A. A. (2014). Frequent users of US emergency departments: Characteristics and opportunities for intervention. *Emergency Medicine Journal, 31*(7), 526-532. 10.1136/emermed-2013-202407

United States Census Bureau. Quick facts: Illinois, population, percent change- April 1, 2010 (estimates base) to July 1, 2017 (V2017). Retrieved from https://www.census.gov/quickfacts/

University of Illinois Hospital & Health Sciences System. (2016). *University of Illinois community assessment of needs (UI-CAN) 2016: Toward health equity.* Retrieved from https://hospital.uillinois.edu/Documents/about/UI-CAN2016_v2.pdf

Uscher-Pines, L., Pines, J., Kellermann, A., Gillen, E., & Mehrotra, A. (2013). Deciding to visit the emergency department for non-urgent conditions: A systematic review of the literature. *Am J Manag Care, 19*(1), 47-59.

Wagner, A. K., Soumerai, S. B., Zhang, F., & Ross-Degnan, D. (2002). Segmented regression analysis of interrupted time series studies in medication use research. *Journal of Clinical Pharmacy and Therapeutics, 27*(4), 299-309. 10.1046/j.1365-2710.2002.00430.x

Wetta-Hall, R. (2007). Impact of a collaborative community case management program on a low-income uninsured population in sedgwick county, KS. *Applied Nursing Research, 20*(4), 188-194. 10.1016/j.apnr.2006.08.009

Woods, K., Karrison, T., Koshy, M., Patel, A., Friedmann, P. & Cassel, C. (1997). Hospital utilization patterns and costs for adult sickle cell patients in Illinois. *Public Health Reports (1974-), 112*(1), 44-51.

Young, G. P., Wagner, M. B., Kellermann, A. L., Ellis, J., & Bouley, D. (1996). Ambulatory visits to hospital emergency departments. Patterns and reasons for use. 24 hours in the ED study group. *Jama, 276*(6), 460-465. 10.1001/jama.276.6.460

Zhou, R. A., Baicker, K., Taubman, S., & Finkelstein, A. N. (2017). The uninsured do not use the emergency department more-they use other care less. *Health Affairs, 36*(12), 2115-2122. 10.1377/hlthaff.2017.0218

Zuckerman, S. & Shen, Y. (2004). Characteristics of occasional and frequent emergency department users: Do insurance coverage and access to care matter? *Medical Care, 42*(2), 176-182. 10.1097/01.mlr.0000108747.51198.41

VITA

NAME:	Sara Wieseneck Heinert
EDUCATION:	B.A., Statistics, Psychology, University of Rochester, Rochester, New York, 2006
	M.P.H., Epidemiology, University of Michigan, Ann Arbor, Michigan, 2008
	Ph.D., Health Policy and Administration, University of Illinois at Chicago, Chicago, Illinois, 2018
PROFESSIONAL MEMBERSHIP:	AcademyHealth
	American Public Health Association
	Society for Academic Emergency Medicine
ABSTRACTS:	Wieseneck S, Krueger D, Matney J, Reichel T. The Relation Between Fear of Crime and a Healthy Lifestyle in Flint, Michigan. Oral Presentation. Michigan Epidemiology Conference. East Lansing, MI, April 2008.
	Beharry MS, Wieseneck S, Conn K, Szilagyi P, Chin N. Deserving and Designing Health Care: Suggestions for Health Care Improvement from Homeless Teens. Poster Presentation. Society for Adolescent Health and Medicine Meeting. New Orleans, LA, March 2012.
	Ojukwu E, Walker K, Heinert S, Hoilette L. Barriers and Facilitators to Becoming Patient Centered Medical Homes Within Community Health Centers in New York State. Poster Presentation. Strong Children’s Research Center Poster Session. Rochester, NY, August 2012.
	Jee SH, Couderc J-P, Gallegos A, Hilliard C, Heinert S, Swanson D. A pilot project using mindfulness-based stress reduction among traumatized youth in foster care. Platform presentation. American Academy of Pediatrics National Conference and Exhibition. Orlando, FL, October 2013.

Chae S, Biskup TM, Heinert S, Lin J. Building Community Trust through Quality Assurance of Malaria Diagnosis and Management at a Rural Clinic in Uganda. Poster Presentation. Society of General Internal Medicine. San Diego, CA, April 2014.

Chae S, Biskup T, Heinert S, Lin J. Using Electronic Medical Record Information for Quality Improvement of Malaria Diagnosis and Management in Uganda. Poster Presentation. American Public Health Association Annual Meeting and Exposition. New Orleans, LA, November 2014.

Cano A, Del Rios M, Aldeen A, Campbell T, Demertsidis E, Heinert S, Vanden Hoek T. Youth Heart Rescue Pilot: A School-Centered Out-Of-Hospital Cardiac Arrest Educational Intervention. Poster Presentation. American College of Emergency Physicians Research Forum. Chicago, IL, November 2014.

Mauntel-Medici C, Lin J, Baghikar S, Basnet S, Heinert S. Utilization of Electronic Medical Record Innovations to Facilitate Routine Opt-out HIV Screening in an Urban Academic Emergency Department. Poster Presentation. Society for Academic Emergency Medicine Mid-Atlantic Regional Meeting. Washington, DC, February 2015.

Heinert S, Brown S, Quander D, Moreno F, Rosen C, Walton S, Vanden Hoek T. Gender Differences in Frequent Emergency Department Utilization. Poster Presentation. University of Illinois at Chicago Women's Health Research Day. Chicago, IL, April 2015.

Heinert S, Brown S, Quander D, Moreno F, Rosen C, Walton S, Vanden Hoek T. Who are Frequent Emergency Department Utilizers? An Exploratory Look at an Urban ED. Poster Presentation. Society for Academic Emergency Medicine Annual Meeting. San Diego, CA, May 2015.

Heinert S, Joseph Colla, TaLana Hughes, Lewis Hsu. Sickle Cell Disease Patient Perspectives on Health Care Experiences and Improvements for the Future: A Mixed Methods Approach. Poster Presentation. Society for Academic Emergency Medicine. San Diego, CA, May 2015.

Lin J, Basnet S, Baghikar S, Mauntel-Medici C, Heinert S. Emergency Department Provider Knowledge and Attitudes on HIV Screening and Potential Impact on Uptake of a Routine HIV Screening Program. Poster Presentation. Society for Academic Emergency Medicine. San Diego, CA, May 2015.

Del Rios M, Kotini P, Heinert S, Foster E, Campbell T, Johnsen C, Weber J, Vanden Hoek T. Association Of Neighborhood Characteristics With Incidence And Survival From Out Of Hospital Cardiac Arrest In Chicago. Oral Presentation. Society for Academic Emergency Medicine Annual Meeting. San Diego, CA, May 2015.

Heinert S, Brown S, Quander D, Moreno F, Rosen C, Walton S, Vanden Hoek T. Sickle Cell Disease Patients Who Frequent an Urban Emergency Department. Poster Presentation. AcademyHealth Annual Research Meeting. Minneapolis, MN, June 2015.

Heinert S, Brown S, Quander D, Moreno F, Rosen C, Walton S, Vanden Hoek T. Who Are Frequent Emergency Department Utilizers in an Urban ED? Poster Presentation. AcademyHealth Annual Research Meeting. Minneapolis, MN, June 2015.

Cano A, Del Rios M, Heinert S, Campbell T, Guzman M, Vanden Hoek T. Disparities in out-of-hospital cardiac arrest: Bystander CPR and its association with race and income in Chicago. Poster Presentation. National Medical Association. Detroit, MI, August 2015.

Agu SI, Brown SB, Hsu L, Vanden Hoek T, Heinert S, Lowe J and Colla JS .Sickle cell patients experience delay in analgesic administration with respect to national guidelines despite severity of presentation. Poster presentation. Mediterranean Emergency Medicine Conference. Rome, Italy, September 2015.

Colla JS, Kotini-Shah P, Rechenmacher R, Fredricks P, Heinert S, Vanden-Hoek T. Acute chest syndrome patients at a sickle cell referral center experience significant delay in analgesic administration despite severity of presentation. Poster presentation. American College of Emergency Physicians Research Forum. Boston, MA, October 2015.

Heinert S, Del Rios M, Bhimani A, Purim-Shem-Tov Y, Christian E. Hypertensive Patient Characteristics, Knowledge, and Barriers and Facilitators to Improve Transitional Care for Hypertension in the Emergency Department. Poster Presentation. American College of Emergency Physicians Research Forum. Boston, MA, October 2015.

Hughes G, Velez J, Heinert S, Brown S, Purakel J, Del Rios M. Treatment and referral of markedly elevated blood pressure in an urban emergency department: How well do emergency physicians adhere to ACEP clinical guidelines? Poster Presentation. American College of Emergency Physicians Research Forum. Boston, MA, October 2015.

Heinert S, Brown S, Quander D, Moreno F, Rosen C, Walton S, Vanden Hoek T. Psychosocial Factors Associated with Frequent Emergency Department Utilization Across Co-Occurring Medical Conditions. Oral Presentation. American Public Health Association Annual Meeting and Exposition. Chicago, IL, November 2015.

Heinert S, Brown S, Quander D, Moreno F, Walton S, Rosen C, Vanden Hoek T. Frequent Emergency Department Utilization Across Four Common Chronic Conditions. Poster Presentation. American Public Health Association Annual Meeting and Exposition. Chicago, IL, November 2015.

Lin J, Basnet S, Mauntel-Medici C, Baghikar S, Heinert S. Factors Influencing Emergency Department Providers' HIV Testing Practices. Poster Presentation. American Public Health Association Annual Meeting and Exposition. Chicago, IL, November 2015.

Heinert S. Using GIS Mapping to Enhance Preventive Emergency Medicine in Chicago. Chicago Public Health GIS Meeting. Invited Lecture. Chicago, IL, November 2015.

Heinert S, Brown S. Alternatives to the Emergency Department: ED Patient Usage and Perceptions of Availability. Poster Presentation. Society for Academic Emergency Medicine Annual Meeting. New Orleans, LA, May 2016.

Kotini-Shah P, Del Rios M, Heinert S, Sanchez E, Vanden Hoek T. Association of Individual Characteristics and Collective Efficacy With Willingness To Perform CPR in Chicago. Poster Presentation. Society for Academic Emergency Medicine Annual Meeting. New Orleans, LA, May 2016.

Purakal J, Heinert S, Colla J, Prendergast H, Hughes-Strange G, Del Rios M. Elevated Blood Pressure In the Emergency Department: How Well Do Emergency Physicians Treat, Inform and Refer Their Hypertensive Patients Based On Chief Complaint? American Society of Hypertension Annual Scientific Meeting and Exposition. New York, NY, May 2016.

Rodos A, Lin J, Hughes G, Heinert S. Rapid Response Team Alerts within 24 Hours of Emergency Department Admission: An Analysis of Patients who Survived Versus Died. Illinois College of Emergency Physicians Spring Symposium. Chicago, IL, May 2016.

Heinert S. UIC Department of Emergency Medicine Innovations in Scholarship Meeting. The CHAMPIONS NETWork: A High School Training Academy for Frontline Health Advocates. Invited Lecture. Chicago, IL, September 2016.

Heinert S. The CHAMPIONS NETWork. Bridging the Gap: Emerging Health Issues in Underrepresented Minorities Symposium. Invited Lecture. Chicago, IL, October 2016.

Heinert S, Mahmood M, Lin L, Matthew A, Chettupally J, Patel V. Exploring the Effect of Patient and Primary Care Physician Relationships on Emergency Department Utilization. Oral Presentation. American Public Health Association Annual Meeting and Exposition. Denver, CO, November 2016.

Heinert S, Prendergast H, Christian E, Purim-Shem-Tov Y, Del Rios M. Emergency Department Provider Practices, Barriers, and Facilitators to Referral of Hypertensive Patients to Primary Care Follow-Up. Oral Presentation. American Public Health Association Annual Meeting and Exposition. Denver, CO, November 2016.

Arya A, Del Rios M, Heinert S, Amirsoltani R, Castro K, Quasim N, Gehm L and VandenHoek T. CHAMPIONS NETWork: Teaching

Chicago High Schoolers About Cardiovascular Disease and Cancer to Improve Health in Their Communities. Oral Presentation. American Public Health Association Annual Meeting and Exposition. Denver, CO, November 2016.

Alvarez A, Del Rios M, Herrera J, Heinert S. Barriers to hypertension awareness, treatment and follow-up among urban Hispanic patients presenting to the emergency department. American College of Physicians Illinois Chapter Northern Region Annual Residents' & Medical Students' Day. Chicago, IL, November 2016.

Alvarez A, Del Rios M, Herrera J, Heinert S. Barriers to hypertension awareness, treatment and follow-up among urban Hispanic patients presenting to the emergency department. Annual American Medical Association Research Symposium. Orlando, FL, November 2016.

Amirsoltani R, Suarez N, Heinert S, Kowalski S, Arya A, Quasim N, Del Rios M, Gehm L, Vanden Hoek T. The CHAMPIONS NETWork: Teaching Chicago high schoolers about cardiovascular disease and cancer to improve health in their communities. Poster presentation. University of Illinois at Chicago Minority Health Conference. Chicago, IL, April 2017.

Escobar-Schulz S, Prendergast HM, Del Rios M, Petzel-Gimbar R, Garside D, Heinert S, Daviglus M. A Hypertension Emergency Department Intervention Aimed at Decreasing Disparities (AHEAD2): Preliminary Results from a Randomized Control Pilot Trial. Medical Organization for Latino Advancement, Poster Presentation. Chicago, IL, November 2017.

Heinert S, Del Rios M, Arya A, Amirsoltani R, Quasim N, Gehm L, Suarez N, Kowalski S. Vanden Hoek T. Community Health And eMPowerment through Integration Of Neighborhood-specific Strategies using a Novel Education & Technology-leveraged Workforce. Illinois College of Emergency Physicians. Oral Presentation. Chicago, IL, May 2018.

Heinert S, Del Rios M, Arya A, Amirsoltani R, Quasim N, Gehm L, Suarez N, Kowalski S. Vanden Hoek T. The Champions Network: Training Chicago High School Students As Health Advocates to Improve

Health Equity. AcademyHealth Annual Research Meeting. Seattle, WA, June 2018.

PUBLICATIONS:

Chen SR, Barrett ES, Velez M, Conn K, Heinert S and Qiu X. Using the Health Belief Model to Illustrate Factors That Influence Risk Assessment during Pregnancy and Implications for Prenatal Education about Endocrine Disruptors. *Policy Futures in Education*. 2014;12(7):961-974.

Iadarola S, Hetherington S, Clinton C, Dean M, Reisinger E, Huynh L, Locke J, Conn K, Heinert S, Kataoka S, Harwood R, Smith T, Mandell DS, and Kasari C. Services for children with autism spectrum disorder in three, large urban school districts: Perspectives of parents and educators. *Autism.* 2014 Sept:1-10.

Del Rios M, Aldeen A, Campbell T, Demertsidis E, Heinert S, Sinchi J, Vanden Hoek T. Save-a-life at the ballpark: 10-min spectator training achieves proficiency in cardiac arrest response. *Resuscitation.* 2015 Feb;87:21-5.

Jee SH, Couderc JP, Swanson D, Gallegos A, Hilliard C, Blumkin A, Cunningham K, Heinert S. A pilot randomized trial teaching mindfulness-based stress reduction to traumatized youth in foster care. *Complementary Therapies in Clinical Practice*. 2015 Aug; Volume 21, Issue 3: 201-209.

Lin J, Mauntel-Medici C, Heinert S, Baghikar S. Harnessing the Power of the Electronic Medical Record to Facilitate an Opt-out HIV Screening Program in an Urban Academic Emergency Department. *Journal of Public Health Management and Practice*. 2017 May/Jun;23(3):264-268. doi:10.1097/PHH.0000000000000448

Heinert S, Carter J, Mauntel-Medici C, Lin J. Assessment of nurse perspectives on an emergency department-based routine opt-out HIV screening program. *Journal of the Association of Nurses in AIDS Care.* 2017 May/June;28(3):316-326. doi: 10.1016/j.jana.2016.12.004.

Lin J, Baghikar S, Mauntel-Medici C, Heinert S, Patel D. Evaluation of an EMR-driven Routine Opt-out HIV Screening Program in an Urban,

Academic Emergency Department. *Academic Emergency Medicine*. 2017 Nov;24(11):1358-1368. doi:10.1111/acem.13277

Prendergast H, Del Rios M, Petzel Gimbar R, Garside D, Heinert S, Escobar-Schulz S, Kotini-Shah P, Brown M, Chen J, Fitzgibbon M, Durazo-Arvizu R, Daviglus M. A Hypertension Emergency Department Intervention Aimed at Decreasing Disparities: Design of a Randomized Clinical Trial. *Contemporary Clinical Trials*. 2018 Jan;64:1-7. doi: 10.1016/j.cct.2017.11.009

Heinert S, Del Rios M, Arya A, Amirsoltani R, Quasim N, Gehm L, Suarez N, Vanden Hoek T. The CHAMPIONS NETWork: Training Chicago High School Students as Health Advocates to Improve Health Equity in Their Communities. *Health Promotion Practice*. (In press) doi: 10.1177/1524839918757755