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PREDICTORS OF NON-ADHERENCE TO PRIMARY CARE FOLLOW-UP AFTER DIAGNOSIS OF ASYMPTOMATIC HYPERTENSION IN THE EMERGENCY DEPARTMENT

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PREDICTORS OF NON-ADHERENCE TO PRIMARY CARE FOLLOW-UP AFTER
DIAGNOSIS OF ASYMPTOMATIC HYPERTENSION IN THE EMERGENCY
DEPARTMENT

by

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DEDICATION

To Shelley Cornell

PREDICTORS OF NON-ADHERENCE TO PRIMARY CARE FOLLOW-UP AFTER
DIAGNOSIS OF ASYMPTOMATIC HYPERTENSION IN THE EMERGENCY
DEPARTMENT

by

STEPHANIE CORNELL

Presented to the Faculty of The University of Texas

School of Public Health

in Partial Fulfillment

of the Requirements

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PREFACE

My passion for public health developed first from a desire to understand more about the context of medicine – we do not practice medicine in a vacuum, and so to consider medicine only from a physiological point of view is absurd. By taking interest in the denominator as well as the numerator, by looking at whole communities, large environments, umbrella policies, and socioeconomic barriers to healthcare, physicians can provide better quality care for their patients by meeting *patient* needs instead of physicians’ or administrators’ needs. Medicine and the need for patient advocates within medicine becomes powerfully relevant when viewed through the lens of public health. This project, specifically, grew out of an evident need for patients to have higher quality follow-up referral after discharge from the Emergency Department (ED), to receive a “warm handoff” in the words of one my mentors, instead of a cold or absent one. My hope is that this work can be used to improve the quality of patient referrals made in the ED.

ACKNOWLEDGEMENTS

I would like to thank my faculty advisor, Dr. Melissa Valerio, as well as each of my committee members, Dr. Cornell, Dr. Taylor, Dr. Krause, and Dr. Revere, without whom I could not have embarked on (much less completed) this journey. They answered early morning emails, distraught telephone calls, and last-minute signature requests without complaint. I would also like to thank Vidya Venkataraman; such enthusiasm for SAS and claims data should shine into all corners of number-crunching offices everywhere. Her contribution to my Claims Data education was truly invaluable.

PREDICTORS OF NON-ADHERENCE TO PRIMARY CARE FOLLOW-UP AFTER
DIAGNOSIS OF ASYMPTOMATIC HYPERTENSION IN THE EMERGENCY

DEPARTMENT

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ABSTRACT

Background: One strategy to decrease uncontrolled hypertension is to increase follow-up with primary care after diagnosis of asymptomatic hypertension in the Emergency Department (ED). To improve such interventions, this study identified risk factors of non-adherence among individuals 18-60 years old with a diagnosis of asymptomatic hypertension in the ED and access to care.

Methods: Data was obtained from the IBM® MarketScan® Commercial Database between January 2012 and September 2015. Rates of non-adherence to follow-up was determined for individuals discharged from the ED with a primary diagnosis of essential hypertension. Multivariate logistic regression was used to calculate adjusted odds ratios. Demographic and structural variables were evaluated to determine their relationship with non-adherence to follow-up.

Results: Two-thirds of the study population did not adhere to follow-up within 30 days. Risk factors for non-adherence included no history of recent visit with primary care (OR=1.87; 95% CI=1.81-1.93) and multiple prior ED visits (OR=1.65; 95% CI=1.57-1.73).

Protective characteristics included history of filling an anti-hypertensive prescription in last year (OR=0.42; 95% CI=0.40-0.43); or history of filling a 30-day anti-hypertensive prescription on day of index event (OR=0.83; 95% CI=0.80-0.87).

Conclusion: Individuals who have not visited primary care or who are at the ED for the third time in 12 months are more likely to be non-adherent to follow-up. History of filling a 30-day anti-hypertensive prescription within one day of index event or in prior 12 months is associated with increased adherence to follow-up and should be further explored as a strategy for encouraging follow-up in this population.

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BACKGROUND

Literature Review

Hypertension in the ED. Hypertension and hypertension-related complaints in the ED are not only prevalent but have increased over the last decade in both the United States and Canada^{1,2}. Individuals who present in the ED with hypertension, defined for individuals under 60 years of age by the Eighth Report of the Joint National Committee (JNC 8) to be blood pressure greater than or equal to 140 mm Hg systolic or greater than or equal to 90 mm Hg diastolic³, can be loosely categorized into three groups: those who have incidental high blood pressure findings unrelated to the chief complaint and are left undiagnosed, those who have high blood pressure diagnosed in the ED but do not exhibit acute symptoms of hypertension-related end-organ damage and are subsequently discharged for follow-up with primary care, and those with a chief complaint that may or may not be hypertension but who are experiencing acute hypertension-related end-organ damage.

The first of these groups, and perhaps the largest proportion of individuals, are left undiagnosed and therefore cannot be studied with a claims dataset^{4,5}. The last of these groups, clearly not asymptomatic, requires emergent admittance to the hospital for treatment. However, the second group represents individuals at risk for falling into the population of hypertensive adults described previously, who have uncontrolled hypertension, a diagnosis, and, if they have insurance, access to care. Interestingly, despite decreases in hospitalization of hypertensive patients in the ED from 2006 to 2012, ED visits with a primary diagnosis of hypertension increased 4.4% each year and comprised about 1% of all adult ED visits². It can

be inferred, then, that relatively more individuals are falling into this second group of individuals who are diagnosed with asymptomatic hypertension and discharged from the ED. This group of individuals is the subject of interest for this study.

Hypertensive individuals without acute end-organ damage discharged from the ED with or without treatment or a prescription for antihypertensive medication have an overall low-risk of short-term risk of complications^{1,6,7}. Guidelines suggest the discharging physician can decide whether to prescribe antihypertensive medication, to refer to a Primary Care Physician (PCP), or to do both. Recent literature goes further to suggest that emergency physicians do have a role in screening for hypertension, in actively encouraging follow-up after an ED visit by securing a follow-up appointment or contacting patients' PCPs, and in using clinical judgment to determine when prescribing antihypertensive medication is appropriate⁸⁻¹¹.

Adherence to follow-up after ED diagnosis. Hypertension remains untreated if an individual is referred to primary care and cannot attain follow-up, and the inaccessibility of primary care has been proposed as an important factor in increased ED use¹². Additionally, studies on timely follow-up after referral from the ED have found that follow-up within a week is difficult to achieve, perhaps even for those with private insurance^{13,14}. Barriers to timely follow-up may include race, socioeconomic status, age, history of mental illness, living environment, insurance status, PCP status, and access to the healthcare system¹¹. In this study, all individuals have presumed access to the healthcare system through commercial insurance.

The dependent variable examined in this study is adherence to follow-up with a PCP after ED discharge. Interventions to increase successful follow-up after referral from the ED have been attempted, with varying levels of success. However, it remains unclear whether one or another method is better for increasing care coordination across more than one ED¹⁵. A better understanding of the risk factors of non-adherence to follow-up after referral from the ED may help to improve intervention efforts in the future and improve hypertension control among the insured, nonelderly population.

Variables of nonadherence in the literature. Prescription nonadherence has been associated with use of the ED for hypertensive management in minority populations¹⁶, but the relationship between prescription nonadherence and using the ED for hypertensive management or prescription nonadherence and nonadherence to follow-up has not been described for a national, commercially insured population. In an attempt to understand this relationship, this study measures prescription adherence for individuals who have a history of hypertension prescription fills in the 12 months prior to the initial ED visit.

Other demographic variables may also have a role in nonadherence to follow-up. Age, specifically, may play a role in hypertension control as adults aged 18-39 have lower rates of awareness, treatment, and control compared with older adults¹⁷. Barriers related to race, history of mental illness, or the living environment are not supported by this database.

Public Health Significance

Cardiovascular disease kills more people worldwide than any other cause of death, making the risk factors for cardiovascular disease, including uncontrolled hypertension, a high priority for interventional public health and preventive medicine¹⁸. The prevalence of hypertension in the United States, as mentioned previously, is significant. According to the National Health and Nutrition Examination Survey for the years 2005-2008, 68 million adults aged 18 years or older had hypertension. Over 50% of hypertensive adults had uncontrolled hypertension, and of these, over 80% were aware of their diagnosis¹⁹. Hypertension is associated with overall shorter life expectancy, and from 2000 to 2010 the death rate attributable to high blood pressure increased by 16%²⁰. In addition to the negative consequences of increased blood pressure on cardiovascular health, hypertension in the U.S. is also a source of health disparity. Of great concern are the disparities in prevalence and/or control among non-Hispanic blacks, women, and Mexican-Americans²¹⁻²⁴.

The monetary cost of hypertension is also significant. The 2010 estimated direct and indirect cost of hypertension was \$46.4 billion, and the direct and indirect cost of cardiovascular disease and stroke is estimated to be \$315.4 billion²⁰. Because chronic disease management with continuity of care is associated with fewer ED visits and lower costs²⁵, hypertension management at the level of the PCP is important. Similarly, because emergency care for nonurgent conditions costs more than care in other settings²⁶, asymptomatic hypertension is more cost-efficiently treated in primary care settings. The increasing number of emergency

department visits and subsequent overcrowding of the ED is another incentive for keeping patients out of the ED and in a primary care setting^{27,28}.

With a greater emphasis being placed on primary care prevention to decrease healthcare costs associated with preventable adverse events, the connection between emergency management of asymptomatic hypertension and primary care follow-up needs to be better understood. Risk factors identified in this study will allow for more targeted interventions in the insured, nonelderly population to increase follow-up and, presumably, to increase likelihood of hypertension control for those who have uncontrolled hypertension due to lack of proper care. The association between ED visits for asymptomatic hypertension and follow-up appointments with a PCP has not been studied. Additionally, adherence rates for follow-up visits after any ED diagnosis for both nonelderly and commercially insured populations is underrepresented in the literature.

Specific Aims

The first aim of this project is to determine the rate of follow-up with primary care after a diagnosis of asymptomatic hypertension in the ED for those with commercial insurance. Follow-up is expected to be less than 100%. The second aim of this project is to explore predictors of non-adherence to follow-up by analyzing the relationship between non-adherence and several demographic and structural variables with multivariate logistic regression.

JOURNAL ARTICLE

Title: Non-adherence to follow-up after asymptomatic hypertension in the Emergency

Department

Proposed Journal: American Journal of Emergency Medicine

I. Introduction

Hypertension (HTN) is one of the leading risk factors affecting global burden of disease and mortality^{29,30}. Despite recent improvements in treatment and control, over 50% of hypertensive adults still suffer from uncontrolled HTN. Of those with uncontrolled HTN, over 50% are aware of their diagnosis, and 85% have health insurance³¹. Novel strategies are needed to improve HTN control³². Recently, Emergency Department (ED) visits with a primary diagnosis of HTN, both with and without hospitalization, have increased, highlighting the ED as an appropriate setting for pursuit of better HTN education, referral to primary care, and improved adherence to follow-up^{1,2,33,34}. A recent study found emergency physicians are unable to predict which patients are at higher risk of non-adherence to follow-up with primary care³⁵, and it remains unclear which interventions increase follow-up after referrals¹⁵. Furthermore, adherence to follow-up after ED discharge has not been studied in association with anti-hypertensive prescription history.

A better understanding of the risk factors for non-adherence may improve interventions in the future and ultimately aid in reducing uncontrolled HTN for those with a known diagnosis

and access to care. This retrospective cohort study sought to identify demographic and structural predictors of non-adherence to follow-up with primary care after primary diagnosis of asymptomatic Essential HTN in the ED. Non-elderly adults, in particular, were studied because increased control of hypertension in a non-elderly population would lead to increased long-term morbidity and mortality benefits compared to older cohorts.

II. Methods

Data source. The study population was derived from the IBM MarketScan® Commercial Database¹, a national convenience sample of commercially insured individuals, representing data from large employers, as well as medium and small firms³⁶. The database includes claims submitted by any provider who saw a covered individual, including in-network providers, out-of-network providers, and visits denied for payment. Use of this database has precedent in the literature and is fully compliant with the Healthcare Information Portability and Accountability Act (HIPAA)³⁷. The study was reviewed by the UT Houston Health Science Center Review Board and deemed to be exempt.

Study population. This was a retrospective cohort study of commercially insured non-elderly adults identified within the MarketScan database from 1 January 2012 through 30 September 2015. Diagnosis was based on *International Classification of Diseases (ICD) -Revision 9* codes for Essential (Primary) HTN (401.1 and 401.9). Individuals included in the study were aged 18-60 years at time of index event, were discharged from the ED without same-day

¹ MarketScan is a registered trademark of IBM Corporation in the United States, other countries or both.

admission to the hospital, were not admitted to an inpatient setting within seven days of index event and were enrolled with insurance for at least two continuous months during the year of the index event (see Figure 1). Inclusion criteria also required having prescription benefit information available through the database. Total data analyzed spanned 12 months before each index event through follow-up, defined as up to 30 days after index event.

Study definitions. Index event was defined as the first ED visit billed with a primary diagnosis of essential hypertension (*ICD 9* codes 401.1 and 401.9) without same-day admission. The primary outcome, non-adherence to follow-up with primary care, was defined as absence of a visit with family medicine, internal medicine, cardiology, geriatrics, nurse practitioners (NP) or physician's assistants (PA) within 30 days of index event. Of note, the database does not include specialty information for NPs or PAs, but it was assumed that a visit for primary diagnosis HTN with a NP or a PA would have occurred in one of the previously defined primary care settings. This is referred to as the "combined analysis." In this analysis, individuals with a primary care visit were excluded if the billing was based on a non-HTN primary diagnosis. While the primary diagnosis for a follow-up of uncontrolled blood pressure would ideally be "HTN," individuals with multiple comorbidities may have been billed for another diagnosis, which took priority for the follow-up visit. Any contact with primary care after discharge from the ED is clinically relevant because checking blood pressure is standard of care for most visits, and hypertensive blood pressure findings would likely be addressed during the encounter. Although if the primary diagnosis was not HTN, it is unclear whether or not the blood pressure or recent ED visit was addressed at the follow-up

visit, these visits are relevant as a sensitivity analysis. Individuals in the sensitivity analysis included all primary care visits within 30 days of the index event, regardless of diagnosis. Both the primary and sensitivity analyses are included in this report.

Thirty days was chosen to represent adherence given existing literature which suggests obtaining follow-up within one week might be an unreasonable expectation for obtaining primary care follow-up after an ED visit in the United States, even for those with commercial insurance^{13,14}.

Demographics and characteristics. Explanatory variables included age and sex (with male as reference), employment status of policy holder, dichotomized into full-time employment or “other”; continuous insurance coverage, defined as coverage for continuous 12 months during year of index event, or non-continuous; and type of insurance benefit plan, dichotomized into PPO or “other.”

Structural variables were included to explore the effects of an individual’s interaction with the medical system prior to and on the day of index event. First, the variable “Not Established with Primary Care” was determined by selecting individuals who were not billed for any visit during the 12 months prior to the index event with a primary care. Second, individuals were identified as “ED High Utilizer” if they had two or more visits to the ED for any diagnosis in the 12 months prior to index event, plus the index event, for a total of three visits within 12 months. Third, the variable “Inpatient Admission in Prior 90 Days” was

determined by selecting individuals who had at least one inpatient admission in the 90 days prior to the index event.

Finally, two pharmaceutical variables were identified. The first variable, ED Prescription, identified individuals who filled a 30-day prescription of an anti-hypertensive medication on the day of index event (day 0) or next day (day 1), likely indicative of prescription by an ED physician, NPs, or PAs. When prescription fill date occurred on Day 1 and follow-up visit also occurred on Day 1, then the individual was excluded from the model to avoid confounding results due to PCP prescription of anti-hypertensives. Prescriptions filled after Day 1 could not reasonably be assumed to have been written in the ED, and prescriptions for days-supply other than 30 days were not included because these time frames did not fit the research question. The second pharmaceutical variable described individuals who filled an anti-hypertensive medication in the 12 months prior to index event. Anti-hypertensives included ACE inhibitors, alpha-beta blockers, beta blockers, calcium channel blockers, loop diuretics, potassium-sparing diuretics, thiazides, and vasodilating agents. Angiotensin-receptor blockers were not included in the analysis due to limitations of the MarketScan database. Prescription data from this database includes mail order prescriptions and specialty pharmacies³⁶.

Statistical analysis. Unadjusted differences between adherent and non-adherent groups were determined by t-tests for the continuous variable and by chi square tests for categorical variables. Logistic regression was used to evaluate the impact of the explanatory variables on

non-adherence to follow-up, adjusting for all risk factors. Random split-sample cross-validation was used to assess the validity of the model in the primary analysis. Akaike and Bayesian information criterion, as well as area under the receiver operator curve, were used to compare relative fit between the model developed in the training sample and the model fit by the validation sample. For sensitivity analysis, we examined differences between the odds ratios for our combined analysis and for those from the sensitivity analysis (any primary diagnosis). Stata 15.1 (StataCorp LLC, College Station, Texas) was used to conduct all analyses³⁸.

III. Results

Characteristics of study subjects: A total of 84,929 individuals met inclusion criteria for this study. The study population included individuals aged 18-60 years, with a mean age of 47.3 (SD = 9.7). A total of 57% were female, and age distribution between males and females was consistent. Plan and coverage information can be found in Table 1. For those who adhered to follow-up, primary care visits were completed with family practice (53%), internal medicine (33%), cardiology (10%), geriatrics (1%), or with a nurse practitioner or physician's assistant (3%). Table 1 describes the characteristics of the combined analysis. There was no missing data in the dataset. Graph 2 shows the day of first follow-up visit for primary diagnosis HTN. Follow-up rate was much decreased after seven days.

Main results: Overall, this study found 66% non-adherence to follow-up for HTN after discharge from the ED. A total of 30,448 (35.9%) individuals had no history of a PCP visit in

the 12 months prior to their index event. Only 4.9% of individuals had a recent inpatient admission, and 11.7% visited the ED two or more times in the 12 months prior to index event. A majority (76.1%) of individuals filled a prescription for anti-hypertensive medication in the 12 months prior to index event, and 13.9% filled a 30-day prescription for anti-hypertensive medication on the day of index event (Day 0) or next-day (Day 1). Of note, 86.2% of those who filled a 30-day prescription for anti-hypertensives also had a history of filling an antihypertensive prescription in the last 12 months, and 30-day prescriptions represent 77% of all prescriptions filled on day 0 to 1 (see Appendix B).

Table 2 shows the adjusted odds ratio for each characteristic in its relationship to non-adherence in the combined model and cross validation models (i.e., training sample and validation sample). Sex and age were not significantly associated with non-adherence. Continuous coverage and PPO-type insurance were statistically significant. Other significant risk factors for non-adherence to follow-up included no history of PCP visit in the prior 12 months (adj. OR=1.81; 95% CI=1.76-1.86), being a high-utilizer of the ED (adj. OR=1.63; 95% CI=1.56-1.71), and history of inpatient admission in the prior three months (adj. OR=1.36; 95% CI=1.28-1.46). Protective characteristics included history of filling a 30-day prescription for anti-hypertensives on Day 0-1 (adj. OR=0.81; 95% CI=0.78-0.84), history of filling anti-hypertensive prescriptions in the past year (adj. OR=0.42; 95% CI=0.41-0.44), continuous coverage (adj. OR=0.94; 95% CI=0.90-0.98) and PPO-type insurance (adj. OR=0.91; 95% CI=0.88-0.94]. Cross validation models included similar findings, with the exception of a non-significant finding for continuous coverage in the validation sample.

Akaike and Bayesian information criterion are included in Table 2, and area under the receiver operator curve (ROC) showed modest fit for each analysis. The sensitivity model, which included individuals with PCP follow-up for *any* diagnosis within 30 days, also had similar findings except that inpatient admission was non-significant and the variable “Not established with PCP” was much more significantly associated with non-adherence compared to the combined analysis (3.07 compared to 1.87). The rest of the results of the sensitivity analysis can be found in Appendix A and are discussed in section IV.

IV. Discussion

In this study, 66% of the population did not adhere to follow-up within 30 days of an ED visit for hypertension. Predictors for nonadherence included no history of PCP visit in the prior 12 months, at least three visits to the ED within 12 months, and recent inpatient visit in the prior 3 months. Factors associated with adherence included filling a 30-day antihypertensive on day 0-1 after index event, history of filled antihypertensive in the last 12 months, PPO-type insurance, and full-time employment.

While other studies have shown that patient-reported lack of a PCP is associated with non-adherence to ED follow-up appointments, this study looked specifically at patient history to show the negative association between lack of recent contact with a PCP and nonadherence to follow-up^{39,40}. It is likely that lack of a PCP and/or lack of a recent PCP visit are both contributing factors to this finding, and future interventions should include both those

without a reported PCP and those who have not been in contact with a PCP in the last 12 months.

Previous research has also found that follow-up within seven days is difficult to obtain and recent hypertension guidelines suggest that severe asymptomatic hypertension can be followed up within 2-4 weeks from an initial encounter^{12,14,41}; however, the rate of office visits seen in this study was much decreased after seven days, and the overall rate is consistent with rates in prior studies with shorter follow-up periods, indicating that extension of the follow-up surveillance window to 30 days after the ED visit does not result in increased adherence to follow-up¹³. It appears that the barriers to follow-up are not exclusive to short-term (within 7 days) follow-up but apply to long-term (within 30 days) follow-up as well. The rate of nonadherence in this study is also consistent with prior evidence that even those with commercial insurance encounter barriers to adhering to follow-up¹³. Interventions to increase adherence to follow-up should continue to focus on individuals both with and without insurance.

Filling a 30-day anti-hypertensive prescription within one day of the index event was significantly associated with adherence to follow-up. Because the majority (86%) of those who filled this prescription had a history of filling anti-hypertensives, it is possible that these individuals were filling a prescription that was already on file at the pharmacy instead of a prescription from the ED. Regardless of whether the ED physician or a PCP prescribed the anti-hypertensive, it appears that for the 14% of the population who filled a prescription for

anti-hypertensives within one day of index event, adherence was more likely. Adherence was also more likely for those who filled an anti-hypertensive in the 12 months prior to the index event, which could be indicative of increased adherence due to familiarity with the disease or due to familiarity with a PCP. ED physicians should be encouraged that prescription of anti-hypertensives increases likelihood of follow-up. This intervention may be especially useful when applied to those who have history of taking anti-hypertensives because, notably, although 76% of the population filled a prescription for anti-hypertensives in the prior 12 months, only 14% of the population filled a prescription on day 0 or day 1 after the index event. This represents a large potential population for intervention.

Those with three or more visits to the ED in 12 months were found to be significantly at risk for non-adherence to follow-up. While this represented a minority (12%) of the study population, ED physicians should recognize individuals on their third visit to the ED within 12 months to be at high risk of not adhering to follow-up for a diagnosis of uncontrolled HTN, and these individuals may require greater interventional efforts.

Recent inpatient admission was found to be a significant risk factor in the primary model but non-significant in the sensitivity model. This likely reflects individuals who followed up but had a comorbid condition that took priority over HTN in the primary diagnosis for billing. Recent inpatient admission does not appear to be a clinically significant risk factor for non-adherence to follow-up. The other difference found between the combined and sensitivity analyses was that not seeing a PCP in the last 12 months was more significantly associated

with non-adherence. Like the previous difference, this is likely because the group of individuals with multiple comorbidities (and therefore higher likelihood of having visited their PCP in the prior 12 months) are included in the broadened primary outcome, and those that are left in the non-adherent group are more likely to be those who do not have multiple comorbidities and have not seen a PCP for any reason.

The association between having PPO-type insurance or Full-time employment and adherence to follow-up is a novel finding in the ED follow-up literature. These could be important clues to the ED physicians on which individuals should be targeted for intervention. This study found no significant difference in follow-up rates based on sex, although females are known to be disproportionately affected by HTN and have not experienced the same improvements in HTN control over the last thirty years²¹.

V. Limitations

This study has several limitations. First, primary diagnosis of HTN was based on *ICD-9* codes in claims data, allowing the possibility of misclassification of diagnoses. This is a well-known limitation to large claims database studies. Second, this is a descriptive study and does not represent causal evidence. Individuals adherent to follow-up may differ from those who are non-adherent in other ways not measured by this study. Specifically, due to limitations of the database, this study lacks individual demographic and socioeconomic variables that may contribute to non-adherence to follow-up, such as race, socioeconomic status, the living environment, and history of mental illness, and these should be examined in

future research¹¹. Additionally, this database is reported to disproportionately represent the southern regions of the United States compared to other regions, which must be taken into account when interpreting the results⁴². Another database limitation is exclusion of visits or services rendered for cash in which no claim was submitted to the insurance company. Regarding prescription limitations, Angiotensin-Receptor Blockers (ARBs) are not included as a cardiac medication subgroup in the MarketScan Database and therefore cannot be identified separate from other cardiac medications. The authors of this study presume that individuals taking ARBs would have similar behavior to those taking other anti-hypertensives included in the study. Finally, this is a national convenience sample representative of the non-elderly, commercially insured population, and results should not be generalized to the uninsured or elderly populations. More research should be conducted to see if these predictors also exist in other populations.

VI. Conclusion

The results of this study have several implications for emergency medicine and primary care interventions. First, the association between lack of history of PCP visit and non-adherence to follow-up may indicate that obtaining a “new-patient” visit or that obtaining a PCP visit after significant time without PCP contact is a limiting factor. Second, this study found several populations to target in future ED interventions to increase hypertension control, including individuals without history of a PCP visit or history of filling an anti-hypertensive prescription in the last year and individuals who visited the ED at least three times within 12 months. ED physicians should also be encouraged to prescribe 30-day anti-hypertensives to

those with asymptomatic hypertension in the ED, especially to those who have taken anti-hypertensives in the past, because it is associated with increased rates of follow-up with primary care.

VII. Acknowledgements

The authors would like to thank Vidya Venkataraman for her invaluable contribution to the methods section of this article.

Table 1: Characteristics of population

Characteristic	Primary Analysis		
	Total (% total) n= 84,929	Non-Adherent (%Row) n= 56,210 (66.2%)	Adherent (%Row) n= 28,719 (33.8%)
Age, mean; <i>standard deviation</i>	47.3; 9.7	46.9; 9.9	48.1; 9.4
Female	47,970 (56.5%)	31,569 (65.8%)	16,401 (34.2%)
Full Time Employment	49,244 (58.0%)	31,780 (64.5%)	17,464 (35.5%)
PPO Insurance	54,105 (63.7%)	35,459 (65.5%)	18,646 (34.5%)
Continuous Coverage ¹	72,347 (85.2%)	47,278 (65.4%)	25,069 (34.7%)
Not Established with Primary Care ²	30,448 (35.9%)	22,829 (75.0%)	7,619 (25.0%)
ED High Utilizer ³	9,940 (11.7%)	7,367 (74.1%)	2,573 (25.9%)
Inpatient Admission in prior 90 days	4,134 (4.9%)	2,960 (71.6%)	1,174 (28.4%)
Filled 30-Day Anti-HTN Rx from ED ⁴	11,769 (13.9%)	7,278 (61.8%)	4,491 (38.2%)
Filled Anti-HTN Rx in prior 12 months	64,632 (76.1%)	39,878 (61.7%)	24,754 (38.3%)

¹Enrolled for 12 months during year of index event

²No history of primary care visit in past 12 months, any diagnosis

³History of ≥2 prior ED visits in 12 months prior to ED visit, any diagnosis

⁴Filled on day 0 or day 1 after index event

Table 2. Adjusted odds ratios of non-adherence for combined analysis and cross validation (training sample and validation sample)

Variable	Combined Analysis	Training Sample	Validation Sample
	Adjusted OR [95% CI]	Adjusted OR [95% CI]	Adjusted OR [95% CI]
Age	0.99 [0.99-1.00]	1.00 [0.99-1.04]	0.99 [0.99-1.00]
Female	0.99 [0.96-1.02]	1.00 [0.96-1.00]	0.99 [0.95-1.03]
Full time employment	0.89 [0.86-0.92]	0.87 [0.84-0.91]	0.91 [0.86-0.95]
PPO Insurance	0.91 [0.88-0.94]	0.90 [0.86-0.94]	0.92 [0.88-0.96]
Continuous Coverage ¹	0.94 [0.90-0.98]	0.89 [0.84-0.95]	0.98 [0.92-1.04]
Not Established with Primary Care ²	1.87 [1.81-1.93]	1.85 [1.77-1.94]	1.88 [1.80-1.97]
ED High Utilizer ³	1.65 [1.57-1.73]	1.64 [1.53-1.76]	1.66 [1.55-1.78]
Inpatient Admission in prior 90 days	1.36 [1.26-1.46]	1.44 [1.30-1.59]	1.28 [1.16-1.41]
Filled 30-Day Anti-HTN Rx from ED ⁴	0.83 [0.80-0.87]	0.81 [0.76-0.86]	0.85 [0.80-0.90]
Filled Anti-HTN Rx in prior 12 months	0.42 [0.40-0.43]	0.41 [0.39-0.44]	0.42 [0.40-0.45]
<i>Goodness-of-fit tests⁵:</i>			
AIC	-	52001.69	51882.38
BIC	-	52096.91	51977.60
ROC	0.6372	0.6388	0.6359

¹Enrolled for 12 months during year of index event

²No history of primary care visit in past 12 months, any diagnosis

³History of ≥ 2 prior ED visits in 12 months prior to ED visit, any diagnosis

⁴Filled on day 0 or day 1 after index event

⁵Key: Akaike Information Criterion (AIC); Bayesian Information Criterion (BIC); Area under the Receiver Operating Curve (ROC)

Figure 1: Inclusion criteria for combined and cross validation analyses, derived from IBM® MarketScan® Commercial Database

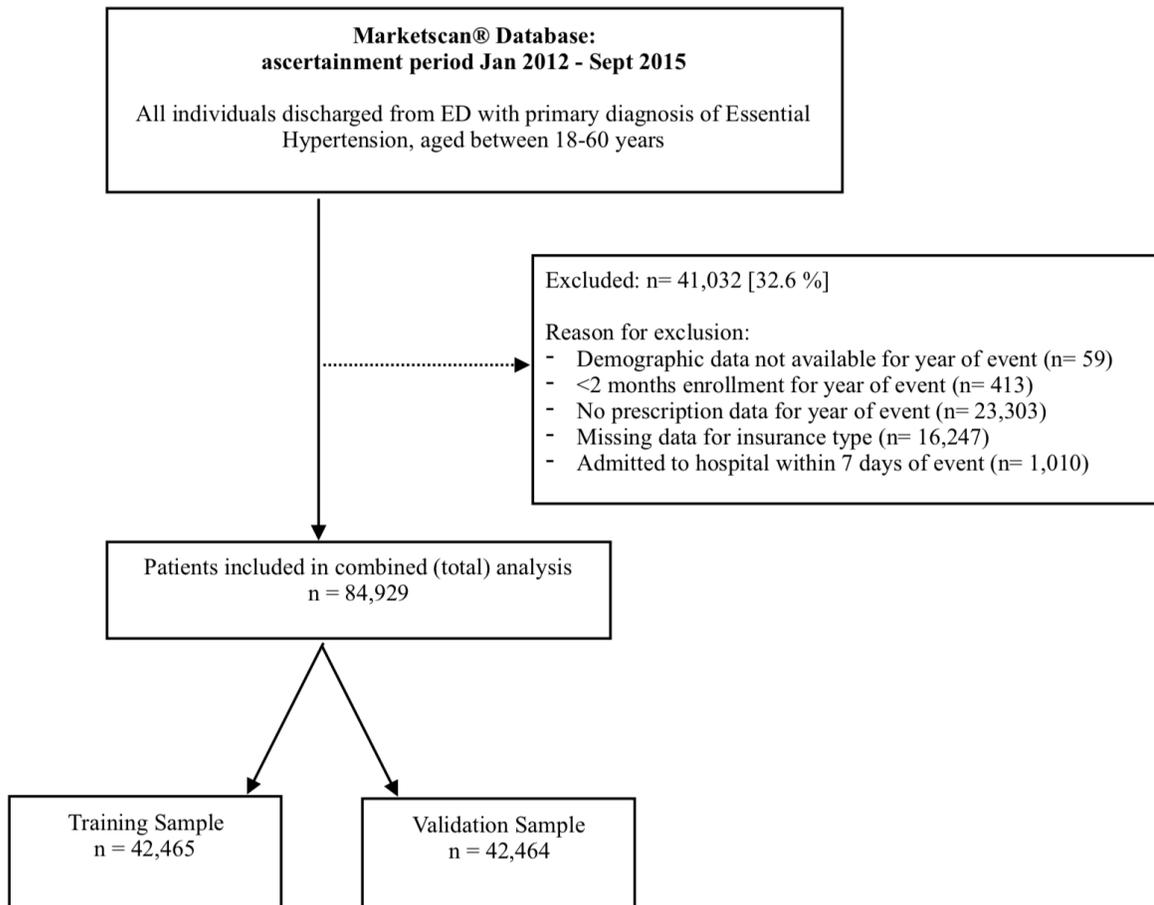
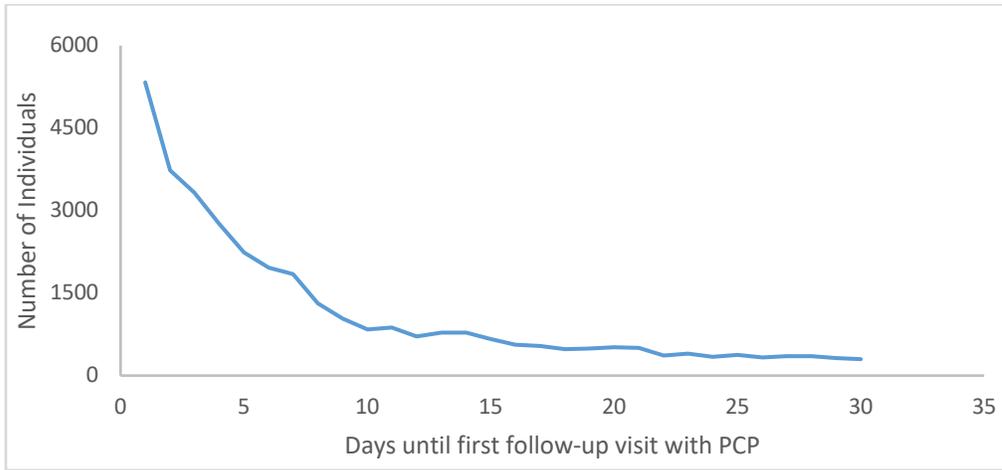


Figure 2. Days until first follow-up visit, primary diagnosis HTN



CONCLUSION

The purpose of this study was to better understand the population who is non-adherent to follow-up after diagnosis of hypertension in the ED, and the findings of this study have implications for both emergency medicine and primary care. Specifically, several predictors of non-adherence and associations with adherence were found which can guide future interventions in the ED and in primary care to increase the quality of referral to primary care. Future research is needed to understand if the predictors identified in this study apply to uninsured populations because if prescription of anti-hypertensives increases adherence to follow-up in both insured and uninsured populations, then current guidelines for emergency providers should be reconsidered. Additionally, claims data cannot provide insight on the “why” behind non-adherence to follow-up, and further research is also needed to better understand barriers to achieving follow-up among the non-elderly, commercially insured population.

APPENDICES

Appendix A: Characteristics and adjusted odds ratios of non-adherence, side-by-side comparison of non-adherence for combined and sensitivity analyses

Characteristic	Combined Analysis		Sensitivity Analysis		
	Total (% total) n= 84,929	Non-Adherent (%Row) n= 56,210 (66.2%)	Non-Adherent (%Row) n= 37,292 (43.9%)	Adjusted OR [95% CI]	Adjusted OR [95% CI]
Age, mean; <i>standard deviation</i>	47.3; 9.7	46.9; 9.9	46.3; 10.0	0.99 [0.99-1.00]	0.99 [0.99-0.99]
Female	47,970 (56.5%)	31,569 (65.8%)	20,571 (42.9%)	0.99 [0.96-1.02]	0.98 [0.95-1.01]
Full Time Employment	49,244 (58.0%)	31,780 (64.5%)	20,419 (41.5%)	0.89 [0.86-0.92]	0.84 [0.82-0.86]
PPO Insurance	54,105 (63.7%)	35,459 (65.5%)	23,167 (42.8%)	0.91 [0.88-0.94]	0.87 [0.85-0.90]
Continuous Coverage ^a	72,347 (85.2%)	47,278 (65.4%)	30,934 (42.8%)	0.94 [0.90-0.98]	0.96 [0.92-1.00]
Not Established with Primary Care ^b	30,448 (35.9%)	22,829 (75.0%)	18,818 (61.8%)	1.87 [1.81-1.93]	3.07 [2.98-3.17]
ED High Utilizer ^c	9,940 (11.7%)	7,367 (74.1%)	4,761 (47.9%)	1.42 [1.57-1.73]	1.42 [1.36-1.49]
Inpatient Admission in prior 90 days	4,134 (4.9%)	2,960 (71.6%)	1,767 (42.7%)	1.36 [1.26-1.46]	1.06 [0.99-1.13]
Filled 30-Day Anti-HTN Rx from ED ^d	11,769 (13.9%)	7,278 (61.8%)	5,056 (43.0%)	0.83 [0.80-0.87]	0.92 [0.89-0.96]
Filled Anti-HTN Rx in prior 12 months	64,632 (76.1%)	39,878 (61.7%)	25,430 (39.4%)	0.42 [0.40-0.43]	0.50 [0.48-0.52]

^aEnrolled for 12 months during year of index event

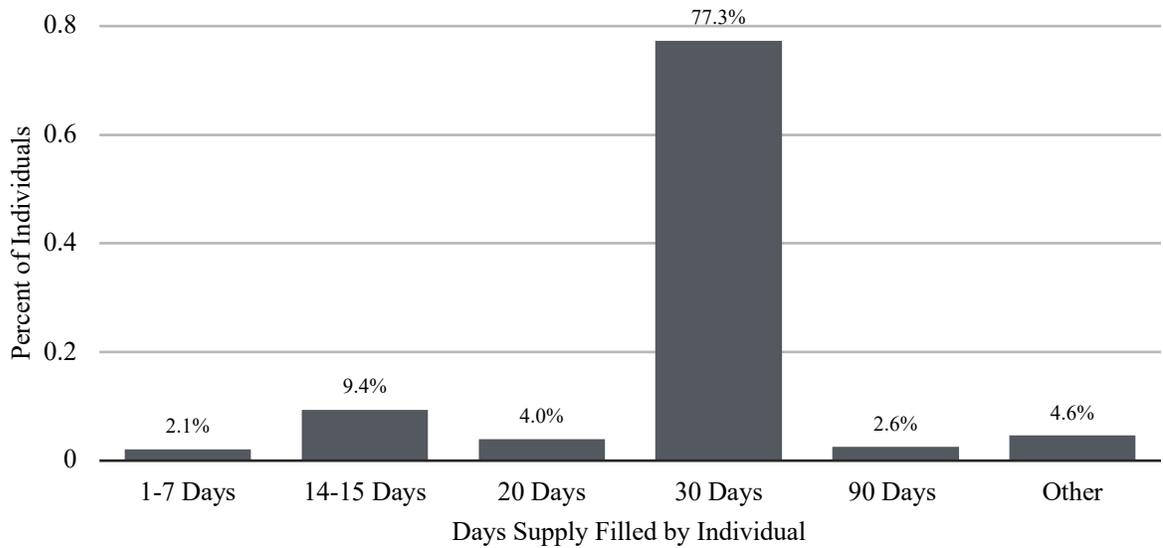
^bNo history of primary care visit in past 12 months, any diagnosis

^cHistory of ≥2 prior ED visits in 12 months prior to ED visit, any diagnosis

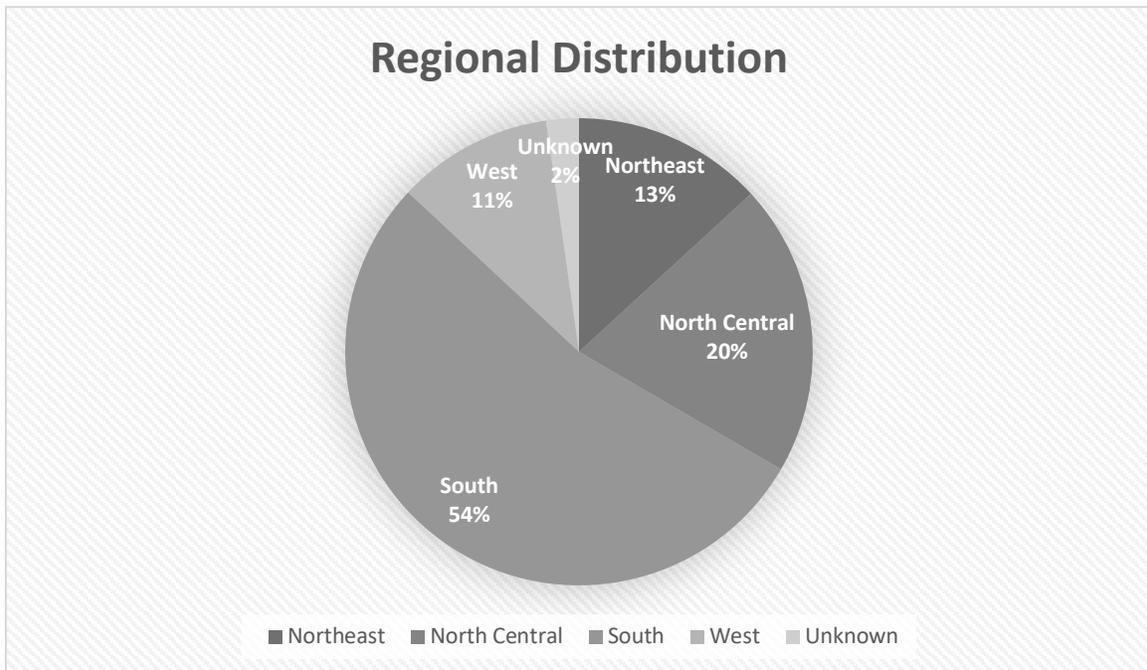
^dFilled on day 0 or day 1 after index event

Key: Akaike Information Criterion (AIC); Bayesian Information Criterion (BIC); Area under the Receiver Operating Curve (ROC)

Appendix B: Days-supply for prescriptions filled on day 0 or day 1 after ED visit



Appendix C: Regional Distribution of Individuals



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