2015

Identifying Problems during Transitions of Care and Reasons for Emergency Department Utilization in Community-Dwelling Older Adults

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Identifying Problems during Transitions of Care and Reasons for Emergency Department Utilization in Community-Dwelling Older Adults

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

by

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December, 2015

Dedication

To my loving husband Tommy

Acknowledgements

I would sincerely like to acknowledge and thank several people who have made this research and goal obtainable. First, I would wholeheartedly like to thank my advisor, Dr. Leticia R. Moczygemba, for her unwavering support and guidance throughout graduate school. Her exceptional mentorship has helped me to grow both professionally and personally. Additionally, her encouragement, friendship, and advice has been invaluable to my success in this program. I would also like to thank my dissertation committee for their commitment to this project and their guidance. Dr. Patricia Slattum for her mentorship, clinical, and research expertise; Dr. Pamela Parsons for her mentorship, clinical, and research expertise; Dr. K.C. Ogbonna for his mentorship, clinical, and research expertise; and Dr. Paul Mazmanian for his mentorship and research expertise. I would also like to acknowledge the American Foundation for Pharmaceutical Education for their generous support of my pre-doctoral fellowship. I am grateful to the Center for Clinical and Translational Research, specifically Bob Grier, for his assistance in providing data for this study.

I am very grateful for all of the outstanding faculty at Virginia Commonwealth University who have facilitated my learning and provided me with a source of inspiration. I would especially like to thank Dr. Norman Carroll, Dr. Sharon Gatewood, Dr. Kelly Goode, and Dr. David Holdford, for their encouragement. I would also like to thank all of my graduate school colleagues and

friends who have been there for me throughout the program and their willingness to always listen and help.

Finally, I am also very grateful for the love and support of my family, without whom this would only be a dream. I am most grateful for my best friend and husband Tommy. I cannot thank you enough for all of your love, encouragement, and support of my academic endeavors. I thank my mom, for her kindness, wisdom, strength, and love has provided me with the inspiration to continue my education. I am grateful for my brothers, Roger and Joe, for all of your love, support, and encouragement. Finally, I regret that my dad could not be here to witness this accomplishment, but I am thankful for the memories of his love and encouragement. I think he would be proud.

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Abbreviations

ADL	Activities of Daily Living
AMA	Against Medical Advice
AOR	Adjusted Odds Ratio
APN	Advanced Practice Nurse
BMI	Body Mass Index
CCI	Charlson Comorbidity Index
CCT	Care Coordination Tool
CI	Confidence Interval
CPI	Consumer Price Index
CT/CAT scan	Computerized Tomography/Computerized Axial Tomography scan
ED	Emergency Department
EMS	Emergency Medical Services
GED	General Educational Development
GLM	Generalized Linear Model
GNP	Geriatric Nurse Practitioner
HCA	Hospital Corporation of America
HUD	United States Department of Housing and Urban Development

ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
IRB	Institutional Review Board
IRR	Incidence Rate Ratio
NEC	Not Elsewhere Classified
NHAMCS	National Hospital Ambulatory Medical Care Survey
NOS	Not Otherwise Specified
NP	Nurse Practitioner
NTOCC	National Transitions of Care Coalition
NYCHA	New York City Housing Authority
NYU ED Algorithm	New York University Emergency Department Algorithm
OR	Odds Ratio
OT	Occupational Therapy
PCP	Primary Care Physician
PHR	Personal Health Record
PIM	Potentially Inappropriate Medication
PT	Physical Therapy
RCT	Randomized Controlled Trial
REALM-SF	Rapid Estimate of Adult Literacy in Medicine – Short Form
REDCap	Research Electronic Data Capture
RHWP	Richmond Health and Wellness Program
RN	Registered Nurse
SD	Standard Deviation

SE	Standard Error
SNOMED-CT	Systematized Nomenclature of Medicine-Clinical Terms
VA	Veterans Affairs
VCC	Virginia Coordinated Care
VCUHS	Virginia Commonwealth University Health System
VIF	Variance Inflation Factor

Abstract

IDENTIFYING PROBLEMS DURING TRANSITIONS OF CARE AND REASONS FOR EMERGENCY DEPARTMENT UTILIZATION IN COMMUNITY-DWELLING OLDER ADULTS

By Antoinette Bartolotta Coe, Pharm.D., Ph.D.

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

Virginia Commonwealth University, 2015

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A mixed methods approach was used for this study. The setting was a low-income, subsidized housing apartment building for community-dwelling older and younger disabled adults identified as a health care hot spot due to high rates of ambulance use. The study purpose was to identify reasons for ED use and problems during transition from ED to home, predictors of zip code 23220 (health care hot spot) in emergent and non-emergent ED visits, and predictors of total ED costs in community-dwelling older adults living in a health care hot spot. Semi-structured interviews with residents who used the ED, an existing database from an interprofessional care coordination and wellness program for residents, and community-dwelling older adults' electronic medical record and billing data from 2010-2013 ED visits from an academic medical center were used. The Gelberg-Andersen Behavioral Model for Vulnerable Populations was

utilized. A total of 14 interviews were conducted. Themes related to ED use included: high use of ambulance services, timely use of the ED or attempt at self-care, and lack of communication with a health care provider prior to ED visit. Themes related to care transitions were: delay in medication receipt after discharge, lack of a current medication list and personal health record, PCP follow-up instruction, and education on warning signs of a worsening condition. The interprofessional program's care coordination activities were education, disease monitoring, referral for PCP visit, and discrepancy reconciliation. A total of 7,805 ED visits were included, of which 3,871 were non-emergent and 1,179 were emergent. Common primary ED visit diagnoses were chest pain and abdominal pain. White race, a Charlson Comorbidity Index score of 3, and a total disease count of 10 or more were significant predictors of zip code 23220 in non-emergent ED visits. White race was a significant predictor of zip code 23220 in emergent ED visits. Significant predictors of total ED costs were white or other race, arrival by ambulance, emergent visit type, and year of visit. Pain was a common reason for ED use. Care transition problems related to medication management and follow-up care indicate an area for targeted interventions after ED discharge.

Chapter 1: Introduction and Literature Review

1.1 Introduction

The older adult population, defined as those age 65 and older, continues to grow in the United States. An almost 25% increase in the older adult population occurred from 2003 to 2013 (35.9 million to 44.7 million).[1] Older adults comprised 14% of the population in 2013 and this is expected to grow to 22% by 2040 (82.3 million).[1] Likewise, emergency department (ED) visits by older adults continue to rise. Studies have shown a 25-34% increase in older adult ED visits over time.[2,3] In 2009-2010, 19.6 million ED visits were by older adults, accounting for 15% of all ED visits in the United States.[4] Many ED visits by older adults may be preventable along with their associated costs. One study indicated that about 40% of ED visits and their associated costs were preventable or non-emergent.[5]

Preventable ED visits are also a concern due to older adults' risk for adverse outcomes after discharge from ED. Older adults may be at risk for adverse outcomes after being discharged from the ED due to fragmented care and multiple chronic conditions.[6,7] Adverse events may be related to ineffective transitions of care between health care settings and result in increased health services use. A transition of care is defined as a "continuous process in which a patient's care shifts from being provided in one setting of care to another, such as from a hospital to a patient's home."[8] Approximately $25 to $45 billion of wasteful spending in 2011 was related to

avoidable complications during transitions of care and unnecessary hospital readmissions.[9] Poor communication, inadequate patient education, and accountability breakdowns lead to ineffective care transitions.[10] Medication-related problems, inadequate follow-up and communication with PCPs, and lack of completion of outpatient tests and procedures are problems that arise during care transitions.[11] Communication between health care providers (e.g. hospitalist and PCP), patient education about their condition and follow-up care, and accountability for the care of the patient during the care transition have been identified as areas for improvement.[11] Frequent use of the ED, especially for non-emergent visits, is also a concern due to the potential for increased adverse outcomes, care transition problems, and increased costs.[5,12]

Frequent use of ED services may be concentrated in a small number of older adult patients. An emerging area of research is the identification of health care hot spots, or geographic areas of high health care use, such as frequent ED utilization. In these areas, costs and health care utilization are related to a small number of patients.[13-15] This study examined ED use by older adults who live in subsidized housing defined as a health care hot spot. Few studies focus on frequent ED use by older adults and related care transition problems. In addition, there is a lack of information with regards to the health status and frequent ED use by older adults residing in health care hot spots or who reside in subsidized housing. This research study adds to the emerging topic of health care hot spots by examining the characteristics of older adults that live in a health care hot spot who use the ED.

A mixed methods approach was used for this study. Semi-structured qualitative interviews were used to identify reasons for ED use and problems that occur during the transition from the ED to the patient's home. The setting was a low-income, independent living, subsidized housing apartment building for community-dwelling older and younger disabled adults. This apartment building was identified as a health care hot spot due to high rates of ambulance use in 2012. An interprofessional program provides care coordination and wellness services to residents in the building. Information from an existing database was examined to describe the demographics of the program's participants and care coordination needs, activities, and outcomes. The Gelberg-Andersen Behavioral Model for Vulnerable Populations was the theoretical framework used to guide the selection of predisposing, enabling, need, and health care use variables. Finally, a secondary analysis of 2010-2013 electronic medical record and billing data from an academic medical center was evaluated for predictors of zip code 23220 (zip code of a health care hot spot) in emergent and non-emergent ED visits. Lastly, total costs for emergent and non-emergent ED visits for community dwelling older adults and a subgroup analysis of ED visits from zip code 23220 were analyzed.

A review of the literature, study purpose, specific aims and hypotheses are provided in this chapter. The methods for this study are presented in Chapter 2 and the results are provided in Chapter 3. Finally, a discussion of study results, practice implications, lessons learned for future research, study limitations, and study conclusions comprise Chapter 4.

1.2 Literature Review

The literature review for this study consists of three sections. The first section summarizes background information about ED use among older adults including: use of ED services and outcomes, arrival to the ED via ambulance, and categorization of ED visits by a validated algorithm. This section also includes a discussion of frequent use of ED services and health care hot spots. In addition, a review of information about older adults living in public housing is presented. Section two covers transitions of care including: a definition of a care transition, problems that occur during care transitions, root causes of ineffective care transitions, care coordination interventions and examples of effective care transition programs, and components of effective care transitions. The third section describes the theoretical framework for this study, the Behavioral Model for Vulnerable Populations. Finally, section four provides the study purpose, specific aims, and hypotheses.

1.3 Section 1: Background on Emergency Department (ED) Use and Older Adults

1.3.1 Older Adult ED Use and Outcomes

Understanding older adult use of ED services is important due to the high costs associated with non-urgent ED use, potential for adverse outcomes, and overall increase in number of ED visits in this group. An increase in the number of older adults' ED visits was suggested in studies using National Hospital Ambulatory Medical Care Survey (NHAMCS) data.[2-4] Results indicated a 25% increase in the number of ED visits in patients aged 65 and older from 2001 (15.9 million ED visits) to 2009 (19.8 million ED visits).[2] Similarly, a 34% ED visit rate increase was seen in older adults aged 65 to 74 years from 1993 to 2003.[3] During this time period, a difference by race in the increasing rate of older adult ED visit use was also observed. African-American older adults had a larger increase (93%, 77 visits per 100 population) compared to white older adults (26%, 36 visits per 100 population).[3] From 2009 to 2010, a total of 19.6 million ED visits were made by adults aged 65 and older.[4] This accounted for 15% of all ED visits in the United States.[4] The ED visit rate was 511 per 1,000 older adults and this significantly increased with age (ED visit rate per 1,000 persons by age group: ages 65-74: 398; ages 75-84: 573; age 85 and over: 832).[4]

As ED visits continue to rise in older adults, the ED visits themselves and their associated costs may be preventable. In a group of high-cost Medicare patients (defined as the top decile of total

cost patients and 10% of the total study sample), 43% of 2009 and 2010 ED visits were classified as preventable and accounted for about 40% of the ED costs.[5] High cost patients accounted for the majority of hospital admissions, inpatient costs, and for 73% of the acute care spending in 2010.[5] In the non-high cost patients, similar percentages of ED visits and costs were preventable; indicating that there is room for improvement in all patients.[5] A higher proportion of high-cost patients were male, black, and Medicare-Medicaid dual eligible.[5] They also had a higher disease burden, including congestive heart failure, stroke, diabetes, cancer, lung, kidney, or liver disease, mental illness or substance abuse increasing the risk for adverse outcomes.[5]

Older adults may be at risk for adverse outcomes after being discharged from the ED due to fragmented care and multiple chronic conditions.[6,7] One study analyzed Medicare Current Beneficiary Survey data for the presence of adverse outcomes in community dwelling older adult Medicare fee-for-service enrollees who were discharged from the ED over a two year period.[16] Adverse outcomes were defined as time to repeat outpatient ED visit, hospital admission, nursing home admission, or death within 90 days of the index ED visit.[16] Of 1,851 beneficiaries, one-third experienced at least one adverse outcome within 90 days of ED discharge.[16] Of those with an adverse outcome, 17% had a repeat outpatient ED visit, 18% were admitted to the hospital, 4% died, and 3% were admitted to a nursing home.[16] The majority of hospitalizations (59%) and repeat ED visits (60%) occurred within the first 30 days of the ED index visit.[16] Significant predictors of adverse outcomes were older age, Medicaid insurance, number of chronic conditions, recent outpatient ED visit or hospitalization within the last six months.[16]

In another study using the same cohort, the ED discharge diagnosis relationship with the time to the first adverse health outcome (i.e. hospital admission or death) was examined.[17] The ED discharge diagnosis for older adults was categorized into four groups: injury or musculoskeletal (MSK) (31%), chronic condition (21%), infection (8%), or non-MSK symptom (22%).[17] The five most common injury or MSK diagnoses were fracture, open wound, contusion or abrasion, back pain or sprain, or other extremity pain or sprain.[17] The five most common chronic conditions were chronic obstructive pulmonary disorder or asthma, congestive heart failure, hypertension, diabetes or hypoglycemia, and cardiac dysrhythmia.[17] For the infection category, urinary tract infection, bronchitis, pneumonia, cellulitis, and ear, nose, and throat infection were the most common conditions.[17] The non-MSK category's most common conditions were chest pain, abdominal pain, dizziness, epistaxis, and syncope.[17] About 12% of the older adults were hospitalized and 1% died within 30 days of ED discharge.[17] Patients seen in the ED for chronic conditions were 1.9 times more likely to be hospitalized or die within 30 days of the index ED visit compared to the other categories of ED discharge diagnoses.[17]

Similar results were found among 942 older adult veterans discharged from the Veterans Affairs Medical Center (VA) ED.[18] Over one-third of veterans discharged from the VA ED had one or more adverse outcomes within 90 days of their discharge.[18] More than one-quarter of patients returned to the VA ED, approximately 13% were hospitalized, and 2% died.[18] The majority of the repeat ED visits (60%) and hospitalizations (57%) occurred within the first 30 days after VA ED discharge.[18] Triage to the ED compared to the urgent care clinic, a higher measure of comorbidity, an ED visit or hospitalization within the last 6 months, and a higher number of medications was significantly associated with adverse outcomes within 6 months.[18]

Identifying predictors of older adult ED visits can provide information to those designing care transition and care coordination interventions and ways to decrease preventable ED use. Older adults are more likely to visit the ED when they live alone compared to living with a spouse, self-rate their health as good, fair or poor compared to excellent, and have at least one hospitalization in the last year.[19] When compared to younger patients, older adults are more likely to arrive to the ED by ambulance, have higher rates of hospital admission, have a primary care physician (PCP), and be referred to the ED by their PCP.[20] They are also more likely to have a longer length of stay in the ED, require an ICU bed, receive more diagnostic tests, and present with a medical condition (not surgical or psychiatric) when compared to younger patients.[20] In a group of older adult Medicare beneficiaries (age $\geq$ 66 years), predictors of ED utilization were: age $\geq$ 85 years, education < 12 years, poor to very good self-rated health compared to excellent, presence of a deficiency in activities of daily living, and the presence of comorbid conditions.[21]

In summary, the number of ED visits by older adults has increased over time. Many ED visits by older adults are preventable along with their associated costs. About one-third of older adults experience an adverse event after their ED visit, with the majority of adverse events occurring within the first 30 days after discharge. Older adults who visit the ED for a chronic condition are more likely to have an adverse event. Older adults are more likely to arrive to the ED via ambulance and use more health care services (e.g. more diagnostic tests, higher rates of hospital admission, require an ICU bed, have a longer length of stay) once in the ED.

1.3.2 Older Adults' Arrival to the ED via Ambulance

There is limited current information about older adults' arrival to the ED by ambulance. Analysis of 2009- 2010 NHAMCS data indicated that 38.3% of older adults arrived to the ED via ambulance and the percentage significantly increased with age (age 65-74: 29.2%; age 75-84: 39.5%; age 85 and over: 54.3%).[4] Older studies suggest that older adults are more likely to arrive to the ED via ambulance than younger patients. A study which examined data from the 2003 NHAMCS- Emergency Department (NHAMCS-ED) component found that older adults have significantly higher rates of ambulance use than younger patients.[22] Another study which combined NHAMCS-ED data from 1997-2000 and 2003-2005 describes at-risk and critically-ill populations' use of ambulance services over several years.[23] At-risk populations were defined as racial or ethnic minorities, older adults, or those who are uninsured.[23] Patients who were admitted to an intensive care unit, went to an operating room, went to a cardiac catheterization laboratory, were intubated, had cardiopulmonary resuscitation, or died in the ED were categorized as critically ill.[23] Researchers found that arriving to the ED by ambulance increased with age and was highest in those 75 years and older.[23] Almost half (45%) of patients aged 75 years and older arrived via ambulance compared to about a quarter of patients aged 65-74 years (27%).[23] The highest percentage of critically ill patients using ambulance services was in patients 75 years and older (67%).[23] Likewise, those with Medicare insurance had a higher rate (33%) of ambulance use compared to private (11%), public (12%), or uninsured patients (14%).

Using a longer time period than the NHAMCS-ED study described above[23], Durant and Fahimi used NHAMCS-ED data from 1997-2000 and 2003-2008 to examine adults' use of ambulance

services for non-urgent conditions.[24] Non-urgent conditions were defined by NHAMCS-ED as those in which treatment could be delayed safely for two to 24 hours.[24] They found that increasing age (in 10 year increments) was associated with a 1.3 times increased risk of ambulance use for low-acuity conditions.[24] A 2.0 times higher risk of ambulance use was observed in older adults (aged 64 and older) with any degree of pain compared to the overall adult group.[24] In addition, those with Medicare insurance were 1.8 times more likely to use ambulance services for non-urgent conditions compared to those with private insurance.[24] Finally, studies of ambulance use in older adults over the last decades have shown an increase in ambulance use with increasing age over 65 years[25,26] and ≥ 85 years compared to 65-84 years[27] and that older adults had a higher rate of ambulance use compared to adults less than 65 years.[28] One study interviewed 279 older adults who arrived to the ED via ambulance about their reasons for ambulance use.[27] Main reasons included inability to get out of the house or immobility, illness or pain-related, other individuals or health care professionals instructing them to use the ambulance, and lack of other transportation.[27]

Increased use of ambulance services in older adults is also reflected in the number of ambulance transport reimbursements by Medicare; which has an impact on health care costs. The number of Medicare Part B reimbursements for ambulance transports increased 69% from 2002 to 2011.[29] This resulted in a 130% increase payments, from $2.0 billion to $4.5 billion.[29] In comparison, all Medicare Part B payments increased 74%.[29] For Medicare fee-for-service beneficiaries, there was a 51% increase nationwide from 2002 to 2011 in the number of ambulance transports between a hospital and a private residence.[29] In the state of Virginia, ambulance transports between a hospital and a private residence increased 170% during the same time frame.[29]

Perhaps most compelling with regards to older adults' use of ambulance services is whether their condition would be more appropriately treated outside of the ED. In an analysis of Medicare claims data for ambulance transports, approximately 35% of annual ambulance transports to the ED are for non-emergent or emergent but primary care treatable conditions.[30] These ambulance transports are estimated to cost Medicare approximately $381 million annually with an associated $622 million in ED costs.[30] Similarly, in 2011 basic life support non-emergent transports were the most prevalent type of transports reimbursed by Medicare accounting for 6.7 million transports and costing approximately $1.9 billion.[29]

In summary, older adults are more likely to use ambulance services and ambulance use increases with age. The number of ambulance transports in older adults has increased over time with associated increased costs to Medicare. Older adult's reasons for deciding to use the ambulance may be related to lack of transportation or mobility, instruction from other individuals or health care providers, or related to illness or pain. Of concern is the preventable use of ambulance services by older adults for non-emergent or emergent but primary care treatable conditions.

1.3.3 Older Adult ED Frequent Use and Health Care Hot Spots

Frequent use or return to the ED is a concern due to the potential for increased adverse outcomes after each visit, potential for care to be more appropriately delivered in a primary care setting versus an ED, and increased costs associated with preventable ED visits. Defining what constitutes frequent use of ED services in older adults is challenging due to varying definitions

of frequent ED use in the literature. Several studies define frequent use by the number of ED visits in the last 12 months. The number of visits considered a criterion for frequent use ranges from at least three ED visits,[31,32] four or more,[33-36] five or more,[37-39] at least six,[40] or 10 or more ED visits in the last year.[41,42] Other definitions of frequent ED use include two ED visits in the previous month or four visits in the previous year,[43] more than three ED visits in one month,[44] and more than eight ED visits over a two year period.[45] Studies have also categorized ED users themselves with high levels of frequent use of ED into two categories. Patients with at least 20 ED visits per year were considered high-frequency users [35] and "hyperusers" had at least 35 ED visits over a three year period.[46]

There are not many studies that specifically focus on frequent use of ED services in older adults. Two studies conducted in Canada and one in the United States which describe predictors or characteristics of frequent ED use in older adults were identified. In over 1,000 older adult patients (age ≥ 65 years) in Canada, predictors of early return (within 30 days) and frequent return (three or more visits in the last six months) to the ED was examined.[32] Older adults who were recently hospitalized, those who felt depressed, and those with heart disease were more likely to return to the ED within 30 days. [32] Those who had poor health, diabetes, an ED visit within the past month, hospitalization within the past six months, feelings of depression, and no help if needed were more likely to visit the ED three or more times during a six month period. [32] Another study conducted in Canada described predictors of frequent ED use in over 12,000 rural older adults (age ≥ 60 years) receiving home care.[47] Frequent ED use was defined as four or more visits in a one year period.[47] Older adults that were younger (age 60-74 years and 75-84 years) compared to 85 years or older, male, had a recent ED visit in the last three months, taking

nine or more medications, and with poor self-rated health were 1.2 to 1.9 times more likely to be frequent ED users.[47] Lack of a caregiver, daily pain, impairments in activities of daily living and instrumental activities of daily living, and presence of certain conditions (hypertension, Parkinson's disease, stroke, Alzheimer's disease) were significantly associated with lower odds of frequent ED use.[47] A retrospective medical record review and survey of older adults (age ≥ 65 years) visiting an urban, academic, tertiary care, United States ED was performed to describe characteristics of frequent users.[48] Frequent ED use was defined as ≥ four visits in a six month period.[48] The chart review identified 268 frequent ED users out of over 5,700 older adults with an ED visit.[48] A higher percentage of older adult frequent ED users were Hispanic or Black compared to White race or ethnicity.[48] Frequent ED users were also more likely to have pulmonary or cardiac problems compared to infrequent ED users.[48] In the 59 frequent ED users that participated in the telephone survey, the majority were female, had Medicare and Medicaid insurance, and reported chronic pain.[48] More than one-third spoke only Spanish, lived alone, and had an education level ≤ 8th grade.[48] Over 90% of the frequent ED users reported having a PCP, but only 36% contacted their PCP before going to the ED.[48] Reasons provided for not contacting their PCP prior to going to the ED included lack of PCP accessibility and emergent ED visit reason.[48]

Frequent use of ED services may be concentrated in a small number of older adult patients. These patients are called "super utilizers" or "super users" and are high utilizers of ED and healthcare services.[13-15] They may have multiple chronic conditions and have social barriers that limit access and coordination of needed care.[15] An emerging concept is that there are geographic areas of high health care use called a health care "hot spot".[14] In these areas, costs are often

related to a small number of patients.[13-15] For example, in Camden, New Jersey, it was found that 30% of health care costs were associated with the care of 1% of the patients, 80% of the costs with 13% of the patients, and 90% of the costs with 20% of the patients.[14] The current study examined ED use by older adults living in a health care hot spot. Specifically, the older adults were residents of a low-income, subsidized housing apartment building described as a health care hot spot based upon high use of ambulance services in 2012. The following paragraphs provide background information about the prevalence and characteristics of older adults who reside in public or subsidized housing. However, there is limited information on this population and none of the articles describe public housing as a health care hot spot.

The 2010 United States Census indicated that there were 40.2 million adult residents age 65 and older.[49] In 2011, 3.9 million older adults' households age 62 years and older had a very low income (≤ 50% area median income); but, only 36% received rental assistance benefits (1.4 million).[50,51] In 2013, data from the United States Department of Housing and Urban Development (HUD) showed that 1.1 million older adults lived in public housing or privately owned developments with unit-based assistance and an additional 483,000 received housing choice vouchers.[50,51]

Although many older adults are served by public housing programs, little is known about the health of these adults over time. Analysis of data from the Health and Retirement Study, a nationally-representative longitudinal study of older adults > 50 years, compared older adults with a history of living in subsidized housing with those who did not.[52] Older adults who

reported living in subsidized housing were older, more often Black or Latino, and had an education level of high school or below compared to those who did not live in subsidized housing.[52] They also had higher proportions of rating their health as poor or fair compared to those who did not live in subsidized housing, higher rates of certain conditions (i.e. hypertension, diabetes, heart conditions, stroke, cancer, arthritis, psychiatric problems, incontinence, fatigue), and a history of falls.[52] In contrast, cross-sectional, regional studies that describe the health status and needs of older adults living in public housing are summarized in Tables 1 and 2.[53-59] The studies are limited in geographic area to Rochester,[53] New York City,[54,56-59] and a medium size city (unidentified in the article).[55] Two articles are primarily descriptive in nature with regards to health conditions of older adults residing in New York City Housing Authority (NYCHA) public housing.[56,57] The other articles provide descriptive results and predictors of cognitive impairment,[53] impairment in activities of daily living,[54] alcohol misuse,[55] mental health care needs,[58] anxiety and depression severity[59] in public housing older adult residents. Older age and poor self-rated health were predictors of cognitive impairment in older adults living in Rochester public housing.[55] The majority of NYCHA older adult public housing residents had at least 1 chronic condition (93%) and 79% had 2 or more chronic conditions.[55] Hypertension, arthritis, and high cholesterol were present in over half of the participants, whereas a quarter of residents had anxiety or depression.[56-59] Interestingly, 11% of NYCHA older adults public housing residents surveyed used the ED as a regular source of care and did not have a personal doctor, while 13% reported not taking medications because of cost.[56,57] Additionally, almost 29% of residents had 1 or more limitations in their activities of daily living.[55] Very low income, age $\geq$ 75 years, 3 or more chronic conditions, obesity, and history of depression were predictors of having a limitation in activities of daily living.[55] Problem alcohol use may also be a concern in older

adults residing in public housing. One study indicated that in older adults who reported drinking alcohol, the majority were classified as having problem drinking behavior (classified as 8-14 drinks per week, ≥ 14 drinks per week, or ≥ 4 drinks in one sitting).[55]

Table 1. Health status and needs of older adults residing in public housing			
Reference	**Study design**	**Outcome assessed**	**Results**
Simning et al. 2014[53] "Cognitive impairment in public housing residents living in western New York"	Cross-sectional Four public housing apartment high rises for adults (age ≥ 50 years) in Rochester, NY with 553 residents Interview with 190 English speaking residents ≥ 60 years 2009-2010	Cognitive impairment (Mini-Cog)	• 27.1% screened positive for cognitive impairment Significant predictors of cognitive impairment: • Age, years: Adjusted Odds Ratio (AOR) 1.07 (95% Confidence Interval (CI): 1.00-1.15) • Very bad or poor self-rated health: AOR 4.56 (95% CI: 1.74-11.96)

Ralph et al. 2013[54] "Multiple chronic conditions and limitations in activities of daily living in a community-based sample of older adults in New York City, 2009"	Cross-sectional New York City Housing Authority (NYCHA) - subsidized housing for over 61,500 older adults (age ≥ 65 years) in New York City, NY 1,016 telephone survey responses linked to NYHCA electronic administrative records Participants were randomly selected and surveys were administered in English, Spanish, Russian, and Chinese June 2009	ADL	• 28.7% at least 1 ADL limitation • 92.9% at least 1 chronic condition (arthritis, osteoporosis, hypertension, high cholesterol, or diabetes) • 79.0% multiple chronic conditions (2 or more chronic conditions) • 75.7% hypertension, 61.3% arthritis, 58.8% high cholesterol, 37.2% diabetes, 27.2% osteoporosis Significant predictors of at least 1 ADL limitation: • Age ≥ 75: AOR 1.6 (95% CI: 1.1-2.2) • Very low income: AOR 2.5 (95 % CI: 1.5-4.1) • Number of chronic conditions: o 3: AOR 2.2 (95 % CI: 1.3-3.9) o 4: AOR 4.3 (95 % CI: 2.5-7.6) o 5: AOR 9.2 (95 % CI: 4.3-19.5) Significant predictors of 3-6 ADL limitations: • Age ≥ 75: AOR 1.9 (95 % CI: 1.2-3.1) • Asian race: AOR 2.6 (95 % CI: 1.1-5.9) • Number of chronic conditions: o 4: AOR 5.5. (95 % CI: 2.4-12.8) o 5: AOR 12.2 (95 % CI: 4.3-34.3) Significant predictors of at least 1 ADL limitation (model includes smoking, obesity, depression): • Age ≥ 75: AOR 1.8 (95% CI: 1.2-2.5) • Very low income: AOR 2.6 (95 % CI: 1.5-4.4) • Number of chronic conditions: o 3: AOR 2.1 (95 % CI: 1.3-3.9) o 4: AOR 3.9 (95 % CI: 2.5-7.6) o 5: AOR 6.0 (95 % CI: 4.3-19.5) • Obesity (BMI ≥ 30kg/m2): AOR 1.7 (95% CI: 1.1-2.4) • Depression diagnosis history: AOR 2.0 (95% CI: 1.3-3.2)

Cummings et al. 2013[55] "Alcohol misuse among older adult public housing residents"	Cross-sectional Health surveys administered to older adults (age ≥ 50 years) residing in public housing apartment buildings in a medium sized city 338 residents met inclusion criteria, 187 completed the survey Summer 2010	Problem alcohol drinking behavior (classified as 8-14 drinks per week, ≥ 14 drinks per week, or ≥ 4 drinks in one sitting)	• 44.4% reported drinking alcohol in the last 30 days • 23.0% had problem alcohol drinking behaviors overall • In those that reported drinking alcohol, 51.2% had problem drinking behavior Significant predictors of problem drinking behavior: • African-American race vs. Caucasian: AOR 4.41 (95% CI: 1.48-13.13) • Male gender: AOR 3.07 (95% CI: 1.14-3.96) • Unemployed vs. retired: AOR 0.21 (95% CI: 0.07-0.65) • Years of smoking: AOR 1.03 (95% CI: 1.01-1.05) • Illegal drug use: AOR 3.48 (95% CI: 1.41-8.55)
Simning et al. 2012[58] "Mental healthcare need and service utilization in older adults living in public housing"	Cross-sectional Four public housing apartment high rises for adults (age ≥ 50 years) in Rochester, NY with 553 residents Interview with 190 English speaking residents ≥ 60 years 2009-2010	Anxiety (Generalized Anxiety Disorder (GAD-7)) Depression (Patient Health Questionnaire (PHQ-9))	• 20.5 % had anxiety • 14.7% had depression • 25.3% had anxiety and/or depression • 31.1% needing treatment Services received: • 9.5% saw a mental health professional in last 6 months • 23.2% prescribed antidepressant • 3.7% prescribed anxiolytic • 21.1% prescribed psychotropic medication (self-reported prescribed medication for any mental health problem) • 28.9% receiving treatment Treatment need: • 54.2% with need were not receiving treatment Stepwise multivariable logistic regression of predictors of treatment need: • Age: AOR 0.90 (95%CI:0.85-0.96) • Social network size: AOR 0.94 (95% CI: 0.90-0.996) • Life events score: AOR 1.19 (95% CI: 1.05-1.35) • Medical service utilization: AOR 1.44 (95% CI:1.29-1.83)

Simning et al. 2012[59] "The characteristics of anxiety and depression symptom severity in older adults living in public housing"	Cross-sectional Four public housing apartment high rises for adults (age ≥ 50 years) in Rochester, NY with 553 residents Interview with 190 English speaking residents ≥ 60 years 2009-2010	Anxiety and Depression symptom severity (Generalized Anxiety Disorder (GAD-7) and Patient Health Questionnaire (PHQ-9))	• Significant correlation between anxiety and depression symptom severity (r=0.61) Significant predictors of anxiety severity (β): • Age (-0.10) • Medical comorbidity (0.17) • Mobility (-0.03) • Perceived social support (-0.06) • Maladaptive coping (0.16) • Life events score (0.51) Significant predictors of depression severity (β): • Age (-0.08) • Medical comorbidity (0.45) • Mobility (-0.03) • Perceived social support (-0.07) • Maladaptive coping (0.17) • Life events score (0.44)

Table 2. Health status and needs of older adults residing in New York City public housing, New York City Housing Authority (NYCHA)					
Reference	**Study Design**	**Select variables**	**Older adults in NYCHA %**	**Older adults in NYC %**	**Older adults in US %**
Parton et al. 2012, Part 1[56] "Health of older adults in New York City public housing: Part 1, findings from the New York City Housing Authority Senior Survey"	Cross-sectional Descriptive report of NYCHA Senior Survey from more than 1,000 randomly selected older adults (age ≥ 65 years) living in NYCHA housing, New York City (NYC), NY NYCHA older adult descriptive results compared to older adults in NYC and US June 2009	Hypertension (HTN)	76%	63%	53%
		Self-reported health status – fair or poor	61%	40%	26%
		High cholesterol (CHOL)	59%	52%	54%
		Seen dentist in last year	44%	61%	57%
		Diabetes (DM)	37%	23%	18%
		History of diagnosed depression	19%	13%	11%
		Arthritis (ARTH)	61%	-	50%
		Activities of daily living (ADL) - at least 1 limitation	29%	-	6%
		Obese	33%	26%	-
		No physical activity in the last month	31%	33%	-
		Current smoker	15%	8%	-
		At least 1 of 5 chronic conditions (DM, HTN, CHOL, ARTH, OP)	93%	-	-
		2 or more chronic conditions	79%	-	-
		Hearing trouble	33%	-	-
		Instrumental ADL - at least 1 limitation	31%	-	-
		No one to help with care	30%	-	-
		Osteoporosis (OP)	28%	-	-
		Trouble eating solid food due to dental problems	27%	-	-
		Severe vision trouble	22%	-	-
		Current depression risk	16%	-	-
		Heart attack or stroke in past 5 years	12%	-	-
Parton et al. 2012, Part 2[57] "Health of older adults in New York City public housing: Part 2, findings from the New York City Housing Authority Senior Survey"	Cross-sectional Descriptive report of NYCHA Senior Survey from more than 1,000 randomly selected older adults (age ≥ 65 years) living in NYCHA housing, New York City (NYC), NY June 2009	Federal or state public insurance	97%	-	-
		Medicare Part D plan	57%	-	-
		Dual eligible Medicare-Medicaid	55%	-	-
		Received flu vaccine in last year	55%	-	-
		Receives food stamps	41%	-	-
		Fall in past year	29%	-	-
		Food insecure (at least 1: food concern, money-related food insufficiency, mobility related food insufficiency)	20%	-	-
		Not taking medication because of cost in the past year	13%	-	-
		Use ED as a regular source of care	11%	-	-
		No personal doctor	11%	-	-
		Accidental burn in last 3 months	9%	-	-
		Did not get care needed in past year	6%	-	-

In summary, several definitions of frequent ED use exist in the literature. However, there is a lack of studies that focus on frequent ED use by older adults. Poor self-reported health, history of a recent ED visit, diabetes, depression, no help if needed, male, African-American race, and Hispanic ethnicity have been identified as predictors of frequent ED use in older adults. In addition to a lack of information about frequent ED use specifically in older adults, there is a lack of information with regards to frequent ED use by older adults residing in health care hot spots. The current study examined ED use by older adults who live in a health care hot spot. The older adults were residents of a low-income, subsidized housing apartment building described as a health care hot spot based upon high use of ambulance services. A review of the literature regarding the health status of older adults who reside in subsidized housing indicated a lack of information regarding frequent use of ED services in this population. This research study adds to the emerging topic of health care hot spots by examining the characteristics of older adults who live in a health care hot spot who use the ED.

1.3.4 Classification of ED Visits and Older Adults

In addition to adding to the literature regarding health care hot spots and older adult ED use, this study also examined ED visits by emergent, non-emergent, and intermediate classification. A literature review identified an algorithm to classify ED visits, from International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) visit diagnosis codes, into four categories: non-emergent; emergent but primary-care treatable; emergent, ED care needed, but preventable; and emergent, ED care needed, and not preventable.[5,60] Researchers at New York University (NYU) Center for Health and Public Service Research and the United Hospital Fund

of New York created this NYU ED algorithm from 1994 and 1999 ED records from six Bronx, New York hospitals.[61] An expert panel of ED physicians reviewed ED visit information to categorize the diagnoses using four steps.[61] The first step categorized the patients as emergent or non-emergent.[61] Emergent was defined as the patient "required contact with the medical system within 12 hours".[61] The next step determined the best care setting for emergent cases.[61] The emergent cases were categorized as ED care needed or primary care treatable.[61] This categorization was based upon review of the ED resources used and procedures performed in the ED.[61] For example, if a procedure used during the visit was not available in a primary care setting (e.g. CAT scan), then it was classified as emergent - ED care needed.[61] Exceptions include conditions which warrant ED use regardless of procedures or resources used (e.g. chest pain).[61] If a visit was emergent, but did not require continuous observation, or no procedures or resources were used that are not available in a primary care setting, it was classified as emergent-primary care treatable.[62] The third step involved mapping the classifications from the first two steps to the patients' discharge diagnoses.[61] This provided percentages of which ED discharge diagnoses were under the categories of non-emergent, emergent- ED care needed, and emergent – primary care treatable.[61] Finally, the researchers reviewed all of the emergent- ED care needed cases and categorized them into preventable/avoidable or not preventable/avoidable.[61] The expert panel determined if the emergent visit was preventable or avoidable with effective and timely primary care.[61,62] An example of an emergent –ED care needed but preventable/avoidable visit is a visit which may have been prevented with proper management of a chronic condition like asthma or diabetes. [61,62] Emergent- ED care needed and not preventable/avoidable included conditions in which primary care could not have prevented the need for ED use (e.g. injury).[61] The NYU ED Algorithm excludes mental health, alcohol, substance abuse, injury, and

unclassified ED visits.[60] Figure 1 represents the categorization of the ED visits by the NYU ED Algorithm.[60,61]

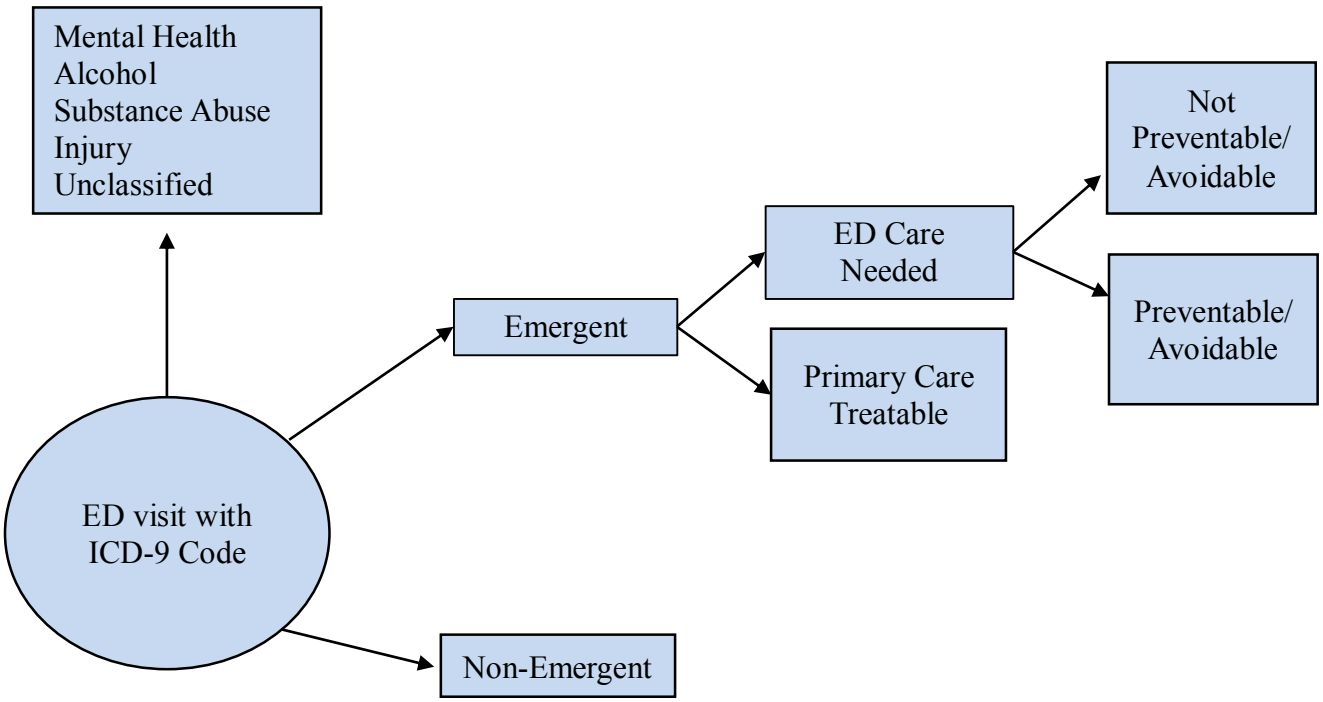


Figure 1. NYU ED Algorithm [60,61]

The NYU ED Algorithm was validated by Ballard and colleagues through its application to over two million commercial and approximately 260,000 Medicare members of an integrated delivery system, Kaiser Permanente-Northern California.[60] The aim of the study was to examine the predictive validity of using the NYU algorithm to classify ED visit severity and its association with the probability of future hospitalizations or death.[60] The time period for this study was 3 years (January 1999 – December 2001).[60] In Medicare patients, approximately 35% of ED visits were non-emergent, 52% were emergent, and 14% were intermediate (i.e. 50% probability of the ICD-9 code being emergent or non-emergent).[60] In comparison, the commercially insured

patients ED visits were classified as approximately 52% non-emergent, 36 % emergent, and 12% intermediate.[60] Female patients were less likely to have a non-emergent visit (Medicare patients: OR=0.82, 95%CI 0.81-0.83; commercially insured patients: OR=0.70, 95%CI: 0.69-0.71).[60] For Medicare patients, emergent ED visits were 3.5 times more likely to result in hospitalization within 1 day, 3.0 times more likely to result in hospitalization within 7 days, and 2.2 times more likely to result in death with 30 days of the ED visit compared to visits categorized as non-emergent. [60] This algorithm has been used in several studies to classify ED visits.[5,60-69] A summary of three recent studies that used this algorithm in older adults' ED visits is provided in Table 3. Use of the ED for non-severe conditions ranged from 20-34%[65,66] and approximately 44% of ED visits in older adults were deemed to be preventable.

In summary, the NYU ED algorithm has been used to classify ED visits by ICD-9-CM diagnosis codes into non-emergent; emergent but primary-care treatable; emergent, ED care needed, but preventable; and emergent, ED care needed, and not preventable visit categories. Validation studies collapsed these categories into emergent, non-emergent, and intermediate ED visit classifications. Results indicated that older adults with emergent ED visits were more likely to be hospitalized or die within 30 days of their ED visit than older adults with non-emergent visits.

Table 3. Studies utilizing the NYU ED algorithm in older adult ED visits			
Reference	**Study Design**	**Definitions**	**Selected Results**
Joynt et al. 2013[5]	Secondary analysis Data source: 2009-2010 Medicare Provider and Analysis Review (MedPAR), and standard 5% Medicare outpatient and carrier files Included: ED visits not leading to an admission in patients ≥ 65 years Excluded: Patients who died in 2009 or 2010 N=1,114,469 patients	*Preventable ED visits:* non-emergent; emergent but primary care treatable; and emergent, ED care needed, preventable/ avoidable NYU ED algorithm categories *High cost patients:* patients in the top decile of total cost in 2010 *Persistently high cost patients:* patients top decile of total cost in 2009 and 2010	High cost patients (n=113,341): • 43% ED visits classified as preventable, these preventable ED visits accounted for 41% of total ED costs in this group Persistently high cost patients (n=31,263): • 45% ED visits classified as preventable, these preventable ED visits accounted for 43% of total ED costs in this group Non-high cost patients (n=1,001,128): • 44% ED visits classified as preventable, these preventable ED visits accounted for 43% of total ED costs in this group
Kaskie et al. 2011[66]	Secondary analysis Data source: Survey on Assets and Health Dynamics among the Oldest Old (AHEAD) interviews (1993,1994) linked to Medicare inpatient, outpatient, and carrier claims (1991-2005) in adults ≥ 70 years Excluded: participants whose AHEAD data could not be linked to Medicare data; that were enrolled in managed Medicare 2 years prior to baseline (lack of comparison to AHEAD fee for service Medicare participants); that required a proxy at baseline AHEAD interview (missing risk factors) N=5,511 AHEAD participants	*Severe ED visit:* probability that the ED was needed ≥ 75% (ED care needed, not preventable/avoidable + ED care needed, preventable/avoidable ≥ 0.75) *Non-severe ED visit:* probability that ED care was needed ≤ 25% (ED care needed, not preventable/avoidable + ED care needed, preventable/avoidable ≤ 0.25) *Indeterminate severity ED visit:* did not meet severe or non-severe ED visit criteria	75% of AHEAD participants had ≥ 1 ED visit, mean of 4.5 ED visits in AHEAD participants with an ED visit Classification of ED visits: • 34% ED visits classified as non-severe • 29% ED visits classified as severe • 37% ED visits classified as intermediate severity Percent hospitalized after ED visit: • 21% of non-severe ED visits • 58% of severe ED visits • 42% of intermediate severity ED visits

Kaskie et al. 2010[65]	Secondary analysis Data source: Survey on Assets and Health Dynamics among the Oldest Old (AHEAD) interviews (1993,1994) linked to Medicare inpatient, outpatient, and carrier claims (1991-2007) in adults ≥ 70 years Excluded: participants whose AHEAD data could not be linked to Medicare data; that were enrolled in managed Medicare 2 years prior to baseline (lack of comparison to AHEAD fee for service Medicare participants); that required a proxy at baseline AHEAD interview (missing risk factors) N=5,510 AHEAD participants	*Severe ED visit, non-severe ED visit, indeterminate severity ED* visit classified same as above. *Individual ED use pattern:* determined by counting the patient's total number of ED visits and calculating if severe, non-severe, or indeterminate severity ED visits accounted for ≥ 50% of the patient's ED visits. Participants were classified into presenting with severe, non-severe, or indeterminate severity patterns.	75% of AHEAD participants had ≥ 1 ED visit, mean of 4.7 ED visits in AHEAD participants with an ED visit Individual ED use pattern (≥ 50% of visits): • 20% non-severe pattern of use • 17% severe pattern of use • 21% indeterminate severity pattern of use • 19% no pattern of use identified Significant predictors of severe ED pattern use compared to indeterminate severity: • Age: AOR 1.4 (95% CI: 1.1-1.7) • Obesity: AOR 1.4 (95% CI: 1.03-1.8) • Heart disease: AOR 1.5 (95% CI: 1.2-1.9) • Hypertension: AOR 1.4 (95% CI: 1.1-1.6) • Hospitalization in the last 12 months: AOR 1.3 (95 %CI: 1.03-1.6) • Rural residence: AOR 1.3 (95% CI: 1.004-1.8) Significant predictors of non-severe ED pattern use compared to indeterminate severity : • Male: AOR 0.8 (95% CI: 0.6-0.96) • Current smoker: AOR 0.6 (95% CI: 0.5-0.9) • Moderate alcohol use: AOR 1.4 (95% CI: 1.03-1.9) • Arthritis: AOR 1.3 (95% CI: 1.04-1.6) • Diabetes: AOR 0.7 (95% CI: 0.5-0.9) • Lung disease: AOR 0.6 (95% CI: 0.4-0.8) • Stroke: AOR 1.7 (95% CI: 1.2-2.3) • Rural residence: AOR 1.5 (95% CI: 1.1-1.9)

1.3.5 Section 1 Summary

In summary, the number of ED visits by older adults has increased over time and many ED visits may be preventable. Adverse events after ED discharge, such as repeat outpatient ED visit, hospital admission, nursing home admission, or death, are common in older adults. Older adults are more likely to arrive to the ED via ambulance and use more health care services in the ED than younger patients. The number of ambulance transports in older adults has increased over time with associated increased costs to Medicare. This study examined ED use by older adults who live in subsidized housing defined as a health care hot spot. Gaps in the literature include: few recent studies that focus on frequent ED use by older adults, a lack of information with regards to frequent ED use by older adults residing in health care hot spots, and limited information about the health status and frequent use of ED services in older adults who reside in subsidized housing. In addition, many studies used survey or health insurance claims data collected several years ago. This study's use of qualitative semi-structured interviews adds patient perspectives about their reasons for ED use that cannot be obtained from survey or claims analysis alone. This research study also adds to the emerging topic of health care hot spots by examining the characteristics of older adults that live in a health care hot spot who use the ED.

1.4 Section 2: Transitions of Care

1.4.1 Problems during Transitions of Care

A transition of care is defined as a "continuous process in which a patient's care shifts from being provided in one setting of care to another, such as from a hospital to a patient's home."[8] During transitions of care, there are multiple opportunities for problems to occur which can increase the risk for adverse outcomes and increase costs due to increased health care service use, such as hospital readmissions. Approximately $25 to $45 billion of wasteful spending in 2011 was related to avoidable complications during transitions of care and unnecessary hospital readmissions.[9] Problems with inpatient-outpatient discontinuity, changes and discrepancies in the medication regimen, an increase in the number of self-care responsibilities, lack of social support, and ineffective physician-patient communication are challenges when a patient leaves the hospital.[70] In one study, almost 20% of patients experienced an adverse outcome after discharge from an academic hospital to home.[12] The majority of adverse outcomes were medication-related (66%), 17% were related to procedures, 5% due to nosocomial infections, and 4% related to falls.[12] Jencks and colleagues found that approximately 20% of Medicare beneficiaries were readmitted within 30 days of hospital discharge and 34% were readmitted 90 days post-discharge.[71] The most frequent reasons for rehospitalization in those with medical conditions were heart failure, pneumonia, psychoses, and chronic obstructive pulmonary disorder.[71] About half of patients that were readmitted within 30 days of hospital discharge did not visit an outpatient physician during the time period between discharge and rehospitalization, indicating gaps in follow-up care after a hospital visit.[71]

The consequences of ineffective transitions are exemplified in a study by Arora et al. which examined older adults' problems after a hospital discharge and their PCP's awareness of their hospitalization.[11] They found that 42% of patients experienced a problem and 30% of PCPs were unaware of their patients' recent hospitalization.[11] In those patients whose PCP was unaware of their hospitalization, 67% reported a post-discharge problem as compared to 32% of patients whose PCPs were aware of their hospitalization.[11] The five most common categories of patient reported post-discharge problems were related to difficulty obtaining follow-up care (e.g. appointment or procedure), need for re-evaluation leading to readmission or return to ED, problems getting medication or therapy, not being prepared for discharge or not ready to go home, and an ongoing problem or question after hospitalization (e.g. post-procedural bleeding or diagnosis question).[11] Qualitative themes that emerged related to patients' perceptions of the communication between their inpatient physician and their PCP included: uncertainty as to whether communication took place, an assumption of good communication, and feeling that the inpatient physician was obligated to communicate with their PCP.[11] The most common theme was patients' uncertainty as to whether communication took place between their inpatient physician and their PCP.[11]

Another study examined inpatient and outpatient PCP medical records for three types of medical errors related to discontinuity of care from an inpatient to outpatient setting.[72] The errors were work-up errors, medication continuity errors, and test follow-up errors. Work-up errors were defined as inadequate patient follow-up by the outpatient provider about an outpatient test or procedure suggested or scheduled by the inpatient provider (e.g. scheduled colonoscopy at discharge and no outpatient work-up). A medication continuity error occurred if a patient did not

have an inpatient discharge medication documented in their medication list at the first possible PCP visit. A test follow-up error occurred if a test result was pending at discharge and no documentation of the test result by the PCP. The main outcome of rehospitalization within three months after the first post-discharge PCP outpatient visit was determined from the hospital's administrative database.[72] Almost half of the patients (49%) experienced one or more medical errors related to discontinuity of care and at least one medication continuity error was experienced by 42% of the patients.[72] Approximately 41% of the patients with a planned follow-up test at discharge experienced at least one test follow-up error.[72] At least one work-up error was experienced by 22% of patients with a planned outpatient work-up.[72] In addition, 32% of patients were rehospitalized within 3 months after their first PCP visit post-discharge.[72] The investigators considered these medical errors were related to a lack of communication from the inpatient provider's hospital discharge plan to the outpatient PCP.[72]

In summary, older adults are at high risk for problems during transitions of care, with approximately 1 in 5 experiencing an adverse outcome. Medication-related problems are a prevalent transition of care problem. Inadequate follow-up and communication with PCPs, lack of completion of outpatient tests and procedures, and problems with medication continuity are areas of concern during care transitions.

1.4.2 Root Causes of Ineffective Transitions of Care

The Joint Commission Enterprise identified communication, patient education, and accountability breakdowns as three root causes for ineffective care transitions.[10] Communication breakdowns occur when care providers do not effectively communicate information to other care providers, the patient, or the patient's caregiver as the patient transitions from one care setting to another or home.[10] Root causes for hand-off communication failures during transitions of care include: the culture does not promote a successful hand-off (e.g. lack of teamwork or respect), ineffective verbal, written, or recorded communication method, and physical transfer of the patient and the hand-off do not occur at the same time.[73] Other factors include a lack of time, interruptions, lack of standardized procedures, inadequate staffing, and lack of patient involvement in the hand-off.[73] Patient education breakdowns occur when the patient or patient's caregiver receives conflicting recommendations, instructions for follow-up care are not included in their care plan, or the patient/caregiver does not understand the care plan or his/her medical condition.[10] Accountability breakdowns occur when there is a lack of a responsible health care provider to ensure that the patient's care is coordinated during a care transition.[10] In addition, there are patient characteristics that may prevent successful care transitions. Older adults may not be prepared for the level of care in their next setting or have unrealistic expectations about their care.[6] They may also not have confidence to provide input or express their feelings about decisions that impact their care plan.[6] Strategies to address these root causes of ineffective transitions of care are discussed below in components of successful care transition interventions.

1.4.3 Components of Successful Care Transition Interventions

Interventions to ensure successful transitions of care are needed to prevent the problems described above. Table 4 summarizes the National Transitions of Care Coalition (NTOCC) targets for improving care transitions.

Table 4. National Transitions of Care Coalition targets for improving care transitions[8]
Ensure communication between providers, patients, and caregivers
Use electronic health records and standardized medication reconciliation practices
Expand the pharmacist's role in medication reconciliation during transitions of care
Implement points of accountability for sending and receiving care (e.g. between PCPs and specialists)
Increase case management and care coordination services
Establish payment systems that incentivize better transitions of care
Develop and evaluate performance on transitions of care measures

The main components that a provider should incorporate for an effective care transition in patients with complex care needs, including older adults are summarized in Table 5.

Table 5. Components of effective care transitions[6]
Communication between the sending and receiving clinician about: 1. A common care plan 2. Summary of care provided by sending institution 3. Patient's goals and preferences (including advance directives) 4. Updated problem list, baseline physical and cognitive functional status, medication list, allergies 5. Contact information for the patient's caregivers and PCP 6. Prepare the patient and caregiver about what to expect during the care transition and the next site of care 7. Reconcile the patient's prior medication list with current regimen 8. Develop and provide a follow-up plan for completing outstanding tests and appointments 9. Discussion with the patient and caregiver about warning signs and symptoms to monitor of a worsening condition and who to contact if this occurs (name and phone number)

Care coordination, or the interaction among health care providers to provide quality care for a patient including a patient needs assessment and development, implementation, and evaluation of a care plan, is one method that has been found to improve outcomes during transitions of care.[8] Table 6 provides examples of care transitions programs and their outcomes; many of which include care coordination. [74-83] Nurses were involved in the majority of the care transition interventions.[75-77,79-83] Multidisciplinary health care teams, nurses and physicians, were also a common component of the care transition programs.[75,77,80-83] Two studies described including other members of the health care team,[75,80] one described inclusion of social workers,[75] two included pharmacists,[81,82] and one included physical and occupational therapists.[81] All of the interventions were targeted at older adults except for Project Re-engineered Discharge (RED) which included adults 18 years and older.[82] However, the mean age of the intervention group in this project was 50.1 years (SD 15.1 years).[82] Several of the studies showed lower 30 day rehospitalization rates [74,75,81-83] and three studies indicated lower costs in the intervention group.[75,82,83] In studies that measured the impact of the intervention on ED use, participants in SafeSTEPS[83] and Project RED[82] care transition interventions were less likely to return to the ED[81,82] whereas several others did not show a significant decrease in ED visits.[75-77,79]

Table 6. Examples of care transition interventions			
Reference and Model	**Study Design**	**Intervention Components**	**Outcomes**
Hansen et al. 2013[74] Better Outcomes for Older Adults Through Safe Transitions (BOOST)	Prospective cohort Clinical acute-care unit and a similar control unit within hospitals Cohort 1: 6 hospitals in 2008 Cohort 2: 24 hospitals in 2009	Mentors (external, expert physicians in quality improvement and transitions) facilitated: • Planning process: Institutional self-assessment, team development, stakeholder buy-in, process mapping, identify evidence-based BOOST tools to help with discharge process • 2-day training on BOOST tools • 5-6 phone calls in 12 month period to assess progress and barriers • Site visit Examples of BOOST tools that hospitals could choose to use: • Admission risk assessment • Discharge readiness checklist • Teach back use • Mandated discharge summary completion • Follow-up phone calls to discharge • Individualized written discharge instruction	Post-intervention period: • Lower average 30-day rehospitalization rates (2% decrease), no difference between matched control units and intervention unit • Mean number of tools implemented: 3.5 ± 0.9
Naylor et al. 2013[75] Transitional Care Model (TCM)	Prospective, quasi-experimental study Mid-Atlantic region 172 at-risk Aetna Medicare Advantage members (65 years or older) who received the TCM compared to a matched control group (155 matched pairs) Oct. 2006 – Apr. 2007	Components • APN- primary coordinator of care provides in-hospital assessment and development of care plan • Home visits by the APN and telephone support (7 days/ week) for ~ 2 months post-discharge • APN accompanies patient to follow-up physician visits • Patients receive individualized care plans centered on their goals • Engagement of patients and caregivers in education and support • APN works with patient and family caregivers, physicians, nurses, social workers, and other health care team members on the patient's plan of care	Intervention group: • 25% reduction in hospital readmissions at 90 days • 28% decrease in total hospital days at 90 days • No significant difference at 6 and 12 months in hospital readmissions or number of hospital days • No significant difference in number of ED, home health visits, or skilled nursing facility admission at 12 months • $439 per member per month decrease in total health care costs at 90 days • Decrease in per member per month costs not statistically significant at 12 months

Ohuabunwa et al. 2013[76] Care Transitions Intervention (modified)	Quasi-experimental design Grady Memorial Hospital, Atlanta, GA 52 older adults (age 60 and older) admitted to the medical unit with one or more of the following: hypertension, stroke, diabetes, heart condition, dementia, or taking 4 or more medications and matched controls Jun. 2008 – Jan. 2009	Components: • Assistance with medication self-management • Patient-centered record maintained by the patient • Timely follow-up with primary or specialty care • Trigger list of "red flags" for patient of a worsening condition and how to respond Discharge Nurse Coach (bachelor's degree, > 15 years' experience) provided: • In-hospital visit within 48 hours of admission • Phone calls at 2, 7, and 14 days after discharge for patients who had caregiver support and were engaged during interaction with the coach in the hospital • Home visits only for participants deemed to have poor caregiver support or difficulty with medication management • During office hours- care transitions team member available by phone to answer questions, After hours- advice available through a nurse via phone	Intervention group: • Higher outpatient primary care use at 30 (40.4 vs. 19.2%), 90 (76.9 vs. 32.7%), and 180 days (65.4 vs. 32.7%) • No significant differences in hospital readmissions, emergency department visits at 30, 90, 180, and 365 days • No significant differences in outpatient primary care use at 365 days

Takahashi et al. 2013[77]
 	
Care Transition Program (CTP)
	Prospective cohort study
	
	Employee and Community Health, Mayo Clinic, Rochester, MN
	
	36 hospitalized patients (17 CTP, 19 usual care patients), age 60 and older, with high risk of readmission, who were discharged from the hospital to the community
	
	Oct. 2011 – Sept. 2012
		• Intervention Team members- nurse practitioner (NP), case manager RN, primary physician, consulting geriatrician
		• NP home visit within 1-3 days post-discharge
		  • Review of medications, hospital admission reason and discharge summary, symptoms, follow-up tests and appointments
		  • Functional and symptom assessment, cognitive evaluation
		  • Additional home visits or telephone follow-up as needed
		• Case manager RN called patients weekly, triaged phone calls if symptoms arose
		• Minimum of 30 days in CTP
			• No difference in 30 day hospital readmission rates or ED visits

Altfeld et al. 2012[78] Enhanced Discharge Planning Program (EDPP)	RCT Urban medical center, Chicago, IL 720 older adults (65 years or older) admitted for an inpatient hospitalization and discharged with 7 or more medications and at risk for follow-up complications Jun. 2009 – Jan. 2010	Social work telephone-based intervention: • Contact patient within 2 days of discharge to assess psychosocial and health needs • Plan created to meet patient needs • Follow-up with service providers (e.g. transportation), scheduling follow-up appointments, obtaining medications	Intervention group: • Higher number communicating with their physician at 30 days (90 vs. 82%) • Higher number of scheduled appointments with their physician at 30 days (93 vs. 81%; OR=2.7, 95% CI: 1.64-4.45) • Higher number of kept appointments with their physician at 30 days (75% vs. 57%; OR=2.1, 95% CI:1.51-2.89) • No differences in 30 day rehospitalization or mortality

Enguidanos et al. 2012[79]
 	
Brief Nurse Practitioner Transition (BNPT) Intervention
	RCT
	
	Managed care medical center, Los Angeles County, CA
	
	199 at-risk older adults (50 years and older) discharged to home without formal in-home care or caregivers
	
	Jul. 2006 – Jun. 2007
		BNPT intervention developed from CTI
		• NP – home visit or telephone call within 72 hours of discharge
		• 1-2 home visits and 1-2 follow-up phone calls
		• Components:
		  • Ensure patient understood discharge instructions, had questions/concerns addressed
		  • Identify medication errors, adherence problems, perform medication reconciliation
		  • Assess patient's needs for resources, services and help patient acquire them
		  • Make sure follow-up appointments are scheduled
		  • Assess whether the patient is having any problems managing their health or symptoms that need addressed
			Intervention group:
			• Fewer physician office visits (mean 9.9, SD (8.5) vs. 11.7, SD(7.7))
			• No difference in ED visits, days spent in hospital, or home health care days of service

Arbaje et al. 2010[80] Geriatric Floating Interdisciplinary Transition Team (Geri-FITT)	Pilot cohort study Academic medical center 717 hospitalized patients (age 70 and older) on four general medicine services (2 Geri-FITT, 2 usual care) Jan. – Dec. 2007	Hospital day 1 or 2: • Geriatric Nurse Practitioner (GNP) geriatric assessment of patient, patient's preferences • GNP-geriatrician creation of care plan • Written documentation in medical record • Verbal communication with patient and medical team Hospital day 2 and on: • Monitoring patient progress and care plan • Co-management of geriatric syndromes • Education of medical and nursing staff about geriatric principles • Needs assessment of patient discharge needs with case manager, rehabilitation therapists • Patient or caregiver education Post-discharge day 1 or 2 • GNP telephones patient or caregiver to address medical concerns, performs medication reconciliation • GNP faxes summary of hospitalization, care plan to patient's PCP	• No difference on 3-item Care Transition Measure survey or satisfaction survey

Dedhia et al. 2009[81] Safe and Successful Transition of Elderly Patients Study (Safe STEPS)	Quasi-experimental pre-post study John Hopkins Bayview Medical Center, Baltimore, MD, Geisinger Medical Center, Danville, PA, Carolinas Medical Center- North East, Concord NC 422 adults (65 and older) admitted to hospitalist services on a general medical floor Pre-intervention control period: Jan. – May 2006 Intervention period: Oct. 2006 – Apr. 2007	5 components: • Initial assessment by hospitalist around geriatric issues (e.g. activities of daily living, cognitive changes) • Case managers notified the patient's PCP of the admission using a "Fast Fact Fax" • Multidisciplinary team (including hospitalists, nursing, physical and occupational therapy, pharmacy, nutrition, case management, social work, home nursing) coordination using a team worksheet in the front of the patient's chart • Physician-performed and pharmacist- reviewed medication reconciliation • Scheduled multidisciplinary discharge meetings with the patient with or without their caregiver providing the patient with written discharge instructions, medication instructions, provider contact information, and a Patient- Provider Agreement which set expectations for the patient, discharge planner, and hospitalist	Intervention group: Within 7 days of discharge: • Less likely to return to the ED or be readmitted to the hospital (3 vs. 10%, OR=0.25, 95%CI:0.10-0.62) • More likely to feel better after the hospitalization (87 vs. 78%, OR=2.33, 95%CI: 1.34-4.05) Within 30 days of discharge: • Less likely to return to the ED (14 vs. 21%, OR=0.58, 95%CI: 0.34-0.99) • Less likely to be readmitted to the hospital (14 vs. 22%, OR=0.55, 95%CI: 0.32-0.94) • More likely to feel better after the hospitalization (84 vs. 71%, OR=2.36, 95%CI:1.41-3.92)

Jack et al. 2009[82]
 	
Project Re-engineered Discharge (RED)
	RCT
	
	Boston Medical Center, MA
	
	749 adults (18 years or older)
	
	Jan. 2006 – Oct. 2007
		3 components:
		• Nurse Discharge Advocate (in-hospital)
		  • Educates patient about diagnoses, makes follow-up appointments and post-discharge services, discusses pending in-hospital tests and follow-up plan, performs medication review, ensure discharge plan follows care guidelines, review with patient what to do if a problem occurs, transmit discharge summary to patient's health care providers, have patient teach-back material covered
		• After-hospital care plan- patient receives a written discharge plan with:
		  • Reason for hospitalization, discharge medication list, contact information of PCP and discharge advocate, follow-up information and calendar labeled with visits and tests, information about needed tests and studies
		• Clinical Pharmacist post-discharge telephone call (2-4 days post-discharge)
		  • Reinforce care plan, review medications, address medication-related problems
			Intervention group:
			• Lower hospital utilization (combined ED visits and readmissions) at 30 days (IRR=0.70, 95%CI: 0.52-0.94)
			• Lower ED visits at 30 days (IRR=0.67, 95%CI:0.48-0.96)
			• 33.9% lower costs than usual care group

Coleman et al. 2006[83]
 	
Care Transitions Intervention (CTI)
	RCT
	
	Integrated delivery system, Colorado
	
	750 community-dwelling older adults (65 years or older) admitted to the hospital with 1 of 11 health conditions
	
	Sept. 2002 – Aug. 2003
		4 pillars:
		• Assistance with medication self-management
		• Patient-centered record maintained by the patient
		• Timely follow-up with primary or specialty care
		• List of "red flags" of a worsening condition and how to respond
		
		Use of:
		• Personal Health Record (PHR) by patient
		• Transition Coach (Advanced Practice Nurse (APN))
		  • In-hospital visit
		  • Home visit within 48-72 hours of discharge
		  • 3 telephone calls within 28 days of discharge
			Intervention group:
			• Lower rates of rehospitalization within 30 days (OR=0.59, 95%CI: 0.35-1.00) and 90 days (OR=0.64, 95%CI (0.42-0.99)
			• Lower rates of rehospitalization for same diagnosis at 90 days (OR=0.50, 95%CI:0.26-0.96) and 180 days (OR=0.55, 95%CI: 0.30-0.99)
			• Lower mean hospital costs at 30 ($784 vs. $918), 90 ($1519 vs. $2016), and 180 ($2058 vs. $2546) days

RCT = Randomized Controlled Trial

1.4.4 Section 2 Summary

A transition of care is defined as a "continuous process in which a patient's care shifts from being provided in one setting of care to another, such as from a hospital to a patient's home."[8] During transitions of care, there are multiple opportunities for problems to occur which can increase the risk for adverse outcomes and increase costs due to increased health care service use, such as hospital readmissions. Older adults are at high risk for problems during transitions of care. Medication-related problems, inadequate follow-up and communication with PCPs, and lack of completion of outpatient tests and procedures are problems that arise during care transitions. Communication between health care providers (e.g. hospitalist and PCP), patient education about their follow-up care and their condition, and accountability for the care of the patient during the care transition have been identified as areas for improvement. Care coordination and care transition interventions have been found to improve outcomes in older adults during transitions of care.

1.5 Section 3: Behavioral Model for Vulnerable Populations

The theoretical framework guiding this research is an adaptation of the Gelberg-Andersen Behavioral Model for Vulnerable Populations (Gelberg-Andersen model) developed from the Andersen Behavioral Model of Health Services Use (Andersen model).[84,85] The Gelberg-Andersen model examines which factors affect a vulnerable population's utilization of health care services, personal health practices, and predictors of health outcomes.[84] The Gelberg-Andersen model incorporates predisposing, enabling, and need factors, from both traditional and vulnerable domains, to predict health behaviors and health outcomes.[84]

The initial Andersen model was developed to predict or explain people's use of health care services as a function of their predisposition to use services, factors that enable or are a barrier to use, and their need for care.[85] Predisposing characteristics include demographics, social structure, and health beliefs.[85] Social structure may include the person's ability to cope with problems, their status in the community, their physical environment, their education level or ethnicity.[85] Another predisposing characteristic is health beliefs, which are defined as the "attitudes, values, or knowledge that people have about health and health services that might influence their subsequent perceptions of need and use of health services."[85] Enabling factors are regarded from both a community and personal perspective.[85] Examples of community enabling resources are the types of medical providers in the community and organizations that provide care.[85] Personal enabling resources include factors which affect the ability to use the health care services in the community, such as income level or health insurance status.[85] Need is another variable which predicts health services use from two perspectives, perceived and evaluated.[85]

Perceived need involves people's views of how they evaluate their own health and functional state and when they feel that they need to use health care services.[85] Evaluated need involves a health care professional's judgment on a person's health status and when care or treatment is necessary.[85]

Further revisions of the Andersen model included health care system variables such as policy, resources, and their organization as predictors of a people's use of health care services.[85] Additional factors included type of services, site of service, purpose of the service, and consumer satisfaction. In addition, primary determinants of health behavior, health behaviors, and health outcomes were included.[85] The health behavior domain included personal health practices (e.g. diet, exercise, self-care behaviors) and use of health services.[85] Health outcomes included perceived health status, evaluated health status, and consumer satisfaction.[85] This version recognized that changes in health behaviors and improvement in health are key outcomes and goals of health services utilization.[84]

The addition of the vulnerable domains in the Gelberg-Andersen revision of the model gives a focus to social structure and enabling resources that are applicable to a vulnerable population, such as the impoverished and elderly.[84] These vulnerable characteristics, such as public benefits, transportation, and telephone access, are included as they may effect a person's access or ability to use health care services and their health.[84] The Gelberg-Andersen model was originally applied to research in homeless patients,[84] but has been used in other studies examining cancer screening in Mexican-American women, health services utilization in homeless adults with

hepatitis B and C, self-reported depression among Hispanics and African-Americans, and access to vision care in a diverse low-income population.[86-89] The Gelberg-Anderson model, with the addition of vulnerable domains, is a good fit for this study with a focus in low-income, older adults. Table 7 provides a summary of studies which used multivariable analyses to examine predictors of older adult ED use. The predictors are categorized by predisposing, enabling, and need factors. Need factors, such as number of comorbidities or previous hospital or ED use, were the most common predictors in studies examining older adult ED use.[16,18,19,21,32]

Table 7. Predisposing, enabling, and need factors of older adult ED use						
Reference	**Study Population and Sample Size**	**Study Design**	**Factors[a]**			**Outcome Variable**
			Predisposing	**Enabling**	**Need**	
McCusker et al., 2000[32]	1,122 ED patients ≥ 65 years with ED visits during the daytime hours on weekdays, during a three month period in 1996 Inclusion criteria: non-critical medical status, orientation to time and place or informant availability Canada	Observational cohort: 6 months past index ED visit	• **Alcohol use*** • Age • Gender • Special residence (senior residence, foster home, or nursing home)	• Lives alone • Limited activities before ED visit • Needed assistance before ED visit • Reduced function • Increased assistance • No daily contact • No help if needed • Low income	• Heart disease* • Hospitalized in past 6 months** • Poor health • Diabetes • Cancer • Stroke • ED visit in past month • ≥ 2 falls in past 6 months • Hearing impairment • Visual impairment • Memory impairment • **Depressed** • Bereavement • > 3 daily medications • Sleeping pill use	30 day return ED visit (early return)
			• Age • Gender • Special residence • **Alcohol use**	• **No help if needed*** • Lives alone • Limited activities before ED visit • Needed assistance before ED visit • Reduced function • Increased assistance • No daily contact • Low income	• Poor health* • Diabetes* • ED visit in the past month* • Hospitalized in past 6 months* • **Depressed*** • Heart disease • Cancer • Stroke • ≥ 2 falls in past 6 months • Hearing impairment • Visual impairment • Memory impairment • Bereavement • > 3 daily medications • Sleeping pill use	3 or more return ED visits in 6 months (frequent return)

Shah et al, 2001[21]	9,784 community-dwelling Medicare beneficiaries ≥ 66 years in 1993 Excluded: 65 year old persons due to need to have previous years information for comorbidity score calculation United States	Secondary analysis of Medicare Current Beneficiary Survey (MCBS)	• Age* • Education < 12 years* • Lives alone* • Gender • Race	• Low income • Supplemental insurance • Trouble obtaining care • Delay care due to cost • Lacking usual source of care	• Self-reported health poor-very good compared to excellent* • ADL deficiencies* • Charlson Comorbidity Index score > 0*	Presence or absence of at least one ED claim
Hastings et al., 2007[18]	942 veterans ≥ 65 years old discharged home from Durham VA Medical Center between July 1-September 30, 2003 and followed in VA primary care Excluded: Patients admitted to the hospital or having missing data United States	Retrospective cohort	• Age • Gender	-	• Number of comorbidities* • ED visit within past 6 months* • Hospitalization within past 6 months* • Number of medications	Adverse events (repeat ED visit, hospitalization, and/or death) within 90 days
Hastings et al., 2008[16]	1,851 community-dwelling Medicare beneficiaries ≥ 65 years with at least 1 outpatient ED visit between January 2000-September 2002 Excluded: Residents of long-term care facilities, those enrolled in a Medicare HMO United States	Secondary analysis of MCBS	• Age* • Gender • Race	• **Medicaid insurance*** • No usual source of care	• Number of chronic conditions* • Outpatient ED visit in past 6 months* • Hospitalization in past 6 months* • Hearing difficulty	Time to first adverse event (outpatient ED visit, hospital admission, nursing home admission, or death)
			• Age • Gender • Race	• **Medicaid insurance*** • No usual source of care	• Vision difficulty* • Number of Instrumental Activities of Daily Living (IADL) deficiencies* • Hospitalization in the past 6 months*	Serious adverse event (hospital, nursing home admission, or death) among those with any adverse outcome within 90 days

Hastings et al., 2008[19]	1,662 community dwelling older adults ≥ 65 years in a 5 county area in North Carolina Included: Patients remaining in the study at time of final interview with data on past 12 months of ED use (self-report and hospitalization files) Excluded: Patients with missing data United States	Secondary analysis of data from The Duke Established Populations for Epidemiologic Studies of the Elderly	• Age • Race • Gender	• Living alone compared to living with spouse* • Annual income • Duke Social Support Index Scales (Social network size, Social interaction, Perceived social support, Assistance given to others, Assistance received from others)	• Hospitalized within the past year* • Good, fair, or poor self-rated health compared to excellent* • Mobility disability or IADL disability compared to non-disabled* • Number of health visits in past year	Any ED visit within the previous year
			• Age • Race • Gender	• Living arrangements • Annual income • Duke Social Support Index Scales	• Hospitalized within the past year* • Good, fair, or poor self-rated health compared to excellent* • Mobility disability, IADL disability, or Activities of Daily Living disability compared to non-disabled* • Number of health visits in past year	ED visit and hospitalization within the previous year

[a] * = statistically significant predictor; Bold font indicates vulnerable domain.

1.6 Section 4: Study Purpose, Specific Aims, and Hypotheses

1.6.1 Study Purpose

There is limited information on ED use or transition of care problems in older adults residing in public or subsidized housing. This research adds to the literature around older adults living in public or subsidized housing and the emerging hot spot topic by examining and describing the characteristics and needs of older adults residing in a health care hot spot. Specifically, the older adults were residents of a low-income, subsidized housing apartment building with a history of high use of ambulance services. An interprofessional care coordination and wellness clinic is located in this apartment building. The purpose of this study was to identify reasons for ED use and problems during transition from ED to home, predictors of zip code 23220 (health care hot spot) in emergent and non-emergent ED visits, and predictors of total ED costs in community-dwelling older adults living in a health care hot spot. Additionally, a subgroup analysis of zip code 23220 emergent and non-emergent ED visits was conducted to identify predictors of total ED costs. A description of the predisposing, enabling, and need factors, and health services use of the interprofessional program participants as well as their care coordination needs, activities performed to fulfill needs, outcomes prevented and occurred is provided. The Gelberg-Andersen Behavioral Model for Vulnerable Populations was the theoretical framework used to guide the selection of predisposing, enabling, need, and health care use variables. Qualitative (resident interviews) and quantitative (existing database, electronic medical record/billing claim) data were examined in this study's mixed method approach. It is anticipated that this study's proposed strategies to decrease ED use for non-emergent conditions and methods to improve transitions of care in older adults residing in a health care hot spot will be useful for the

interprofessional program in this study. Results may be valuable to other low-income, subsidized housing apartment buildings for older adults with similar health care needs and ED use. Practice-based research lessons learned can be applied in future studies.

1.6.2 Specific Aims and Hypotheses

This section presents the proposed aims and hypotheses of this research.

Specific Aim 1

1A: Identify and categorize reasons for ED use in community-dwelling older adults.

1B: Identify and categorize reasons for problems that occur during the transition from ED back to residence in community-dwelling older adults.

1C: Describe the predisposing (e.g. age, gender, ethnicity/race, education level), enabling (e.g. insurance type, PCP, years of residence in apartment building, social network, transportation source, telephone access, use of assistive devices, Activities of Daily Living), and need (e.g. number of medications, type and number of chronic conditions, type and number of mental health conditions, substance abuse history) characteristics and use of health services or health behaviors (e.g. ED visits, hospitalizations, PCP visits, use of RHWP clinic) of the RHWP participants. Describe RHWP clinic use and reason for visits (e.g. number of clinic visits per patient, main patient reasons for clinic use (chief complaint)), problems identified (e.g. potentially inappropriate medication use or care transition problem), and services or care coordination provided. Describe patient self-report of ED use (e.g. number of ED visits per patient, main reasons for ED visit, care provided in the ED, and outcome of ED visit), patient's

scores on validated tools (e.g. Geriatric Depression Scale), and modified tools (e.g. Care Coordination Measurement Tool).

1D: Examine the association between predisposing, enabling, and need characteristics and health behaviors of the RHWP participants with the occurrence of care transition problems.

HA1: Patients with a higher number of medications will be more likely to experience a care transition problem.

HA2: Patients with a lack of follow-up with their PCP will be more likely to experience a care transition problem.

HA3: Patients with a higher number of chronic conditions will be more likely to experience a care transition problem.

HA4: Patients who have help or aid in the home will be less likely to experience a care transition problem.

HA5: Patients with the ability to drive will be less likely to experience a care transition problem.

HA6: Patients with higher levels of independence will be less likely to experience a care transition problem.

H07: There will be no difference between other predisposing (age, gender, race/ethnicity, education level), enabling (insurance type, years of residence, telephone access, use of assistive devices), need (mental health conditions, substance abuse history), and health behavior characteristics (RHWP use, hospitalizations, ED visits) with the presence of a care transition problem.

1E: Examine the association between predisposing, enabling, and need characteristics and health behaviors of the RHWP participants with ED use.

HA8: Patients with a hospitalization within the past six months will be more likely to have an ED visit than those who were not hospitalized.

HA9: Patients with diabetes will be more likely to have an ED visit than those without diabetes.

HA10: Patients with heart disease will be more likely to have an ED visit than those without heart disease.

HA11: Older patients without a PCP are more likely to have an ED visit than those with a PCP.

HA12: Patients without help or aid in the home will be more likely to have an ED visit than those who do.

HA13: Older patients will be more likely to have an ED visit than younger patients.

HA14: Patients with a higher GDS score will be more likely to have an ED visit than those with a lower GDS score.

H015: There will be no difference between other predisposing (gender, race/ethnicity, education level), enabling (insurance type, years of residence, transportation source, telephone access, use of assistive devices, Activities of Daily Living score), need (number of medications, substance abuse history), and health behavior characteristics (PCP visit, RHWP use) and the presence of an ED visit.

Specific Aim 2

2A: Describe the demographics (age, race, gender) and use characteristics (location of ambulance pick-up, location of transport destination, reason for transport (destination code), date and time of transport, urgent vs. non-urgent) of all ambulance transports in the Richmond area and for all ambulance transports from the low-income, subsidized housing apartment building.

2B: Compare ambulance use before and after the start of the RHWP for older adults at the low-income, subsidized housing apartment building.

HA16: The number of ambulance transports from this apartment building will be lower after the start of RHWP.

H017: Demographics (age, race, gender) will have no effect on the number of ambulance transports after the start of RHWP.

H018: Day of transport will have no effect on the number of ambulance transports after the start of the RHWP.

H019: Time of transport will have no effect on the number of ambulance transports after the start of the RHWP.

H020: There will be no change of the number of urgent ambulance transports from this apartment building after the start of the RHWP.

HA21: The number of non-urgent ambulance transports will be lower after the start of the RHWP.

2C: Compare use of ambulance services by older adults by zip code to identify areas of high utilization in the Richmond area.

2D: Examine the relationship between demographic (age, race, gender) and utilization variables (reason for transport, date, and time of transport) with non-urgent ambulance transports to the ED.

HA22: Older patients will have increased use of non-urgent ambulance transports to the ED.

HA23: Male patients will have higher use of non-urgent ambulance transport to the ED.

H024: Race will have no effect on the use of non-urgent ED ambulance transports.

H025: Day of the week will have no effect on the use of non-urgent ED ambulance transports.

H026: Time of transport will have no effect on the use of non-urgent ED ambulance transports.

Specific Aim 3

3A: Describe demographics and ED visit characteristics for older adults in an urban, safety-net hospital.

3B: Examine the relationship between demographics and ED visit characteristics and zip code of patient residence.

For non-emergent ED visits:

HA27: Patients who live in zip code 23220 with a non-emergent ED visit will be older than those who do not live in zip code 23220.

HA28: Patients who live in zip code 23220 with a non-emergent ED visit will have higher CCI scores than those who do not live in zip code 23220.

HA29: Patients who live in zip code 23220 with a non-emergent ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.

HA30: Patients who live in zip code 23220 with a non-emergent ED visit will have higher total costs than those who do not live in zip code 23220.

HA31: Patients who live in zip code 23220 with a non-emergent ED visit will have a higher disease count than those who do not live in zip code 23220.

H032: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, visit procedures, disposition, and number of prescribed medications in a non-emergent ED visit by patients who live in zip code 23220.

For emergent but primary-care treatable ED visits:

HA33: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will be older than those who do not live in zip code 23220.

HA34: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will have higher CCI scores than those who do not live in zip code 23220.

HA35: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.

HA36: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will have higher total costs than those who do not live in zip code 23220.

HA37: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will have a higher disease count than those who do not live in zip code 23220.

H038: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, visit procedures, disposition, and number of prescribed medications in an emergent, but primary care treatable ED visit by patients who live in zip code 23220.

For emergent, ED care needed, but preventable/avoidable ED visits:

HA39: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will be older than those who do not live in zip code 23220.

HA40: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will have higher CCI scores than those who do not live in zip code 23220.

HA41: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.

HA42: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will have higher total costs than those who do not live in zip code 23220.

HA43: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will have a higher disease count than those who do not live in zip code 23220.

H044: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, visit procedures, disposition, and number of prescribed medications in an emergent, ED care needed, but preventable/avoidable ED visit by patients who live in zip code 23220.

3C: Examine the relationship between demographics, ED visit characteristics, and billing costs.

All patients aged ≥ 65 years old using VCUHS ED:

HA45: Living in the 23220 zip code area will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA46: Increasing age will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA47: Larger CCI scores will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA48: Arrival to the ED via ambulance will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA49: Higher total disease count will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA50: Higher total visit procedures will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

H051: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, disposition, and number of prescribed medications on total ED billing costs.

Only patients living in zip code 23220 using VCUHS ED:

HA52: Participation in RHWP will be a significant negative predictor of total ED billing costs, while controlling for all other variables in the model.

HA53: Increasing age will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA54: Larger CCI scores will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA55: Arrival to the ED via ambulance will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA56: Higher total disease count will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

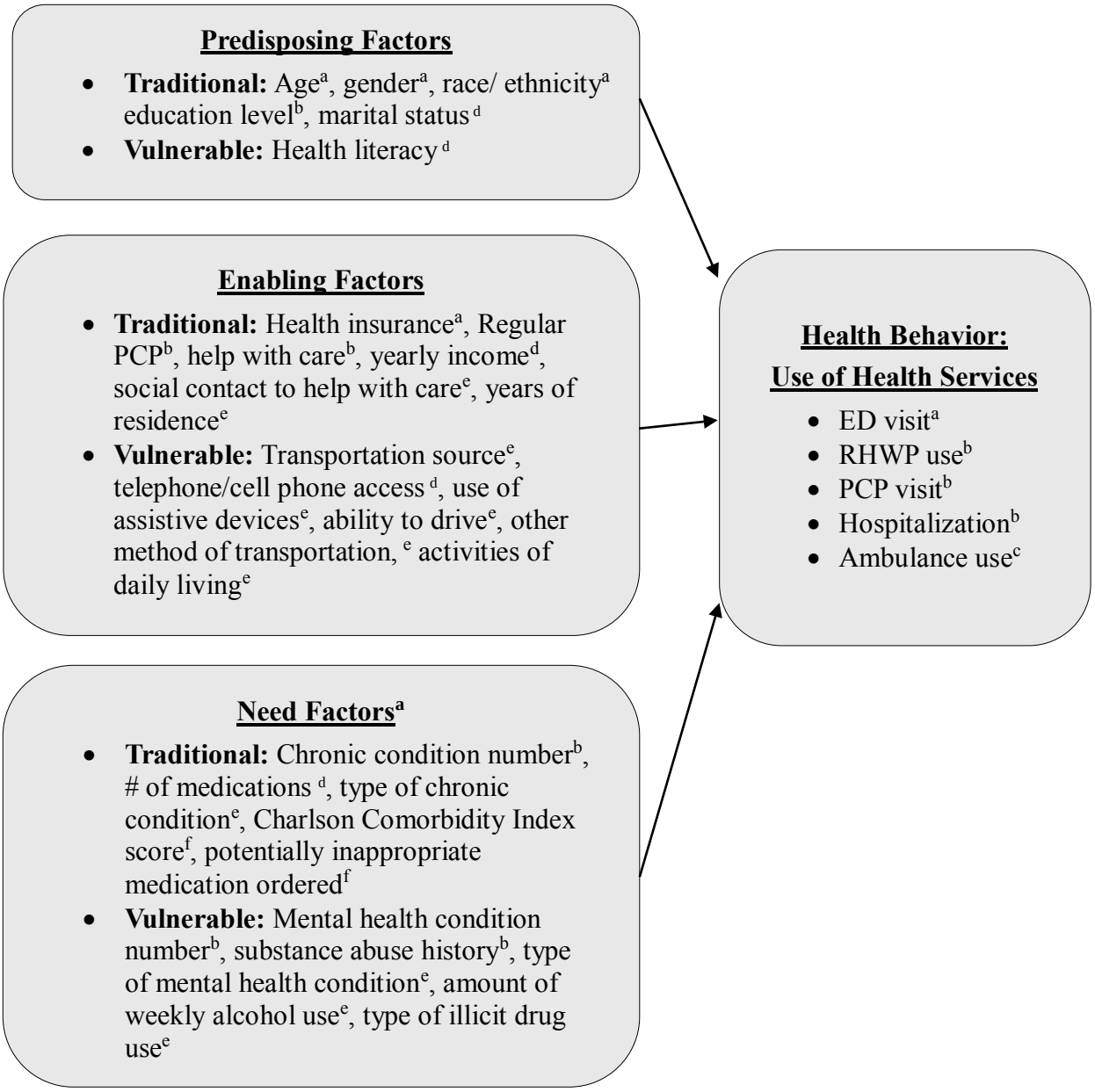
HA57: Higher total visit procedures will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

H058: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, disposition, NYU ED algorithm category, and number of prescribed medications on total ED billing costs.

Chapter 2: Methods

2.1 Chapter Overview

This study used a mixed methods approach to examine the specific aims. The theoretical framework guiding this research was an adaptation of the Gelberg-Andersen Behavioral Model for Vulnerable Populations (see Figure 1). Four data sources were planned for use in this study: 1) resident interviews from a low-income, subsidized housing apartment building in central Virginia (Aims 1A-1B); 2) participant chart information from the Richmond Health and Wellness Program (RHWP) at this location (Aims 1C-1E); 3) Virginia Department of Health ambulance transport data (Aims 2A-2D); and 4) 2010-2013 electronic medical record data from Virginia Commonwealth University Health System (VCUHS) ED (Cerner) and billing records (IDX GE) (Aims 3A-3D). The methodology for each aim are described separately. A description of reasons for not being able to address certain components of each aim is also included. VCU Institutional Review Board (VCU IRB) protocols were approved before commencing this study.



[a] **Data source:** Resident interviews, RHWP participant charts, VCUHS data
[b] **Data source:** Resident interviews, RHWP participant charts
[c] **Data source:** Resident interviews, VCUHS data
[d] **Data source:** Resident interviews
[e] **Data source:** RHWP participant charts
[f] **Data source:** VCUHS data

Figure 2. Study predisposing factors, enabling factors, need factors and use of health services

2.2 Study Design: Aim 1

A qualitative analysis using semi-structured interviews was used to address Aims 1A and 1B. Information from RHWP participant charts was used to examine Aims 1C-1E. Setting, study population, inclusion and exclusion criteria for Aims 1A-1E, and study design for Aims 1A-1B and 1C-1E (as separate sections) are presented below.

2.2.1 Setting and Study Population

The setting for Aim 1 was a Section-8, 247 unit apartment building in central Virginia. It primarily houses adults aged 62 years and older or individuals with disabilities and is considered a health care "hot spot" (i.e. geographic area of high health care utilization). For example, data from the Richmond Ambulance Authority data showed 153 ambulance transports to EDs from this apartment building in 2012. Of these 153 ambulance transports, 151 (98.7%) were classified as non-emergent.

In this health care hot spot apartment building, an interprofessional program, the Richmond Health and Wellness Program for Older Adults (RHWP), provides care coordination and health and wellness services. RHWP focuses on improving coordination of services during transitions of care, disease monitoring, and communication with participants' PCPs. The interprofessional care team consists of a nurse practitioner, pharmacist, psychology, medicine, and social work

faculty. The core faculty also collaborates with a physician and nurse practitioner for those patients who do not have a PCP. Interprofessional education also occurs at the clinic, in which students from nursing, pharmacy, medicine, psychology, and social work collaborate to provide patient care under the supervision of faculty preceptors. In 2012, the majority of the residents were female (55%), African-American (62%), and lower income with 53% receiving less than $9,999 annually and 41% receiving between $10-19,999 annually. Approximately 15% of the residents were disabled.

2.2.2 Inclusion and Exclusion Criteria

Inclusion criteria for participation in Aims 1A and 1B was not limited to residents who participate in the RHWP clinic. All apartment building residents aged 18 years and older who visited the ED within the last thirty days and completed informed consent were eligible for Aims 1A and 1B. Aims 1C - 1E was limited to residents who participate in the RHWP clinic

2.2.3 Study Design – Aims 1A and 1B

1A: Identify and categorize reasons for ED use in community-dwelling older adults.

1B: Identify and categorize reasons for problems that occur during the transition from ED back to their residence in community-dwelling older adults.

2.2.3.1 Sampling and Recruitment Strategy

Aims 1A and 1B used purposeful sampling to identify residents for participation in semi-structured interviews.[90-92] Purposeful sampling allows for selecting information-rich cases for in depth study.[92] "Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the inquiry".[92] The strategy used for purposeful sampling in this study was a mixture of criterion sampling and convenience sampling. The criterion reviewed was visiting the ED within the last 30 days. The participant would then self-identify for participation in the study (convenience sample). Criterion sampling is used to understand information rich cases that may reveal opportunities for program improvement (e.g. help design interventions that RHWP may implement to improve transitions of care).[92] The sample size for these aims was based on the number of participants required to reach redundancy or saturation (i.e. when no new information is obtained).[91, 92]

A flyer (Appendix 2) was designed and approved by VCU IRB to advertise the study and used for recruitment. The flyer contained information and contact information to learn about the study. The flyer was posted on bulletin boards and approved first floor sign areas. If the resident coordinator, any RHWP clinic provider, or the RHWP clinic coordinator identified a resident with an ED visit in the last 30 days, they gave the resident a flyer with the researcher's contact information. Interested residents contacted the researcher via phone or face-to-face to learn more about the study. In addition to the recruitment flyer, the researcher attended a resident breakfast meeting, family dinner and resident awards night, and a new resident event meeting to describe the study to residents and answer any questions. Study participants were given $15 cash for their time spent in the interview session.

2.2.3.2 Description of Interviews

Semi-structured interviews were used to gain information to identify and describe the types of problems encountered during care transitions from the ED to their residence and reasons for their occurrence. The interview also elicited the participant's perspective about the reason for their ED use.

The interview script and questions are provided in Appendix 3. The list of questions for the interviews is provided in Table 8. The first set of questions addressed a participant's reasons for ED use and their experience in the ED. The second set of questions addressed transition of care problems, guided by the four pillars of the Coleman Care Transition Intervention.[83] These pillars include medication management, provision of a personal health record, timely follow-up care, and knowing warning signs and symptoms of a worsening condition (i.e. "red flags").[83] These pillars are recommended as part of a successful care transition and were used to evaluate problems that may have occurred during the resident's transition from ED to home. Probing questions were used to gain more insight into resident's answers. After the questions about their ED experience and transition of care, participants were read a structured questionnaire that collected demographic, health related variables, and use of RHWP clinic and responses were recorded. The variables collected, grouped by predisposing, enabling, and need factors, are provided in Table 9. A brief, validated instrument to assess participant literacy, the Rapid Estimate of Adult Literacy in Medicine - Short Form (REALM-SF), was administered as the last part of the interview.[93] The REALM-SF assesses medical word reading (word recognition) and has been validated in predominantly African-American, older adult cohorts.[93] The participant

was given the REALM-SF list of words to read and the researcher marked their pronunciation of seven words as: “Correct”, “Mispronounced”, or “Not attempted” and then scored their response to the corresponding grade level category.[93]

Table 8. Questions for residents recently using the ED
Reason for ED visit
1. Which ED did you visit? When? 2. Please describe your reason for using the ED. If for a non-urgent reason, why did you choose to go to the ED? 3. How did you arrive to the ED? 4. What tests did they perform in the ED? 5. How did the ED visit help your problem? 6. How long did you have the problem associated with your ED visit? 7. Did you see a health care provider for this problem before going to the ED? If so, who? 8. What medications were you on prior to going to the ED? Were there any recent changes to your medications?
Transitions of Care based upon Coleman’s Care Transition Intervention[83]
Medication Management
1. Were you prescribed any medication in the ED to take after your visit? If yes, which medications? 2. Did you get your medications filled after your ED visit? If no, why not? 3. Do you use a pillbox or other reminder system to manage your medications? 4. Do you have a current medication list?
Personal Health Record
1. Do you have a personal health record? (The personal health record should include an active problem list, medications and allergies, whether advance care directives had been completed, and a list of red flags, or warning symptoms or signs for the patient’s chronic illnesses. Space should be available for the patient to record questions and concerns in preparation for his or her next encounter. If patient brought information from ED visit, please review.) 2. What information do you have to provide to your primary care doctor or other healthcare provider about your recent ED visit? Did you get a copy of your care plan?
Follow-up
1. What health care providers are you supposed to see for follow-up? 2. Have you seen them? Have you made the appointment? 3. What did you share about your ED visit?
“Red Flags”
1. What are the warning signs and symptoms that you condition is getting worse? 2. What are you supposed to do if you notice your condition is getting worse?

Table 9. Demographic and health-related variables collected during resident interviews	
Variables	**Definition**
Predisposing	
Traditional Domains	
Age	Years (continuous)
Gender	Male / Female
Marital status	Never married / Married / Divorced / Widowed
Ethnicity/Race	Caucasian / African-American / Native American / Hispanic / Asian / Other
Education	Highest level completed
Enabling	
Traditional Domains	
PCP	PCP (Yes/No)
Insurance	Medicare / Medicaid / Medicare-Medicaid Dual Eligible / Other
Income	Yearly income (<$9,999 / $10,000-19,999/ ≥ $20,000)
Social network	Anyone to help with your care (yes/no), who
Vulnerable Domains	
Transportation source	Regular source of transportation (yes/no); what type
Telephone access	Telephone (Yes/No), Cell phone (Yes/No)
Health Literacy	REALM-SF[93] grade level (≤ 3rd grade; 4th – 6th grade; 7th – 8th grade; ≥ 9th grade)
Need	
Traditional Domains	
Number of medications	Total number of medications (continuous)
Number of chronic conditions	Total number of chronic conditions (continuous)
Vulnerable Domains	
Number of mental health conditions	Total number of mental health conditions (continuous)
History of substance abuse	Substance abuse history (Yes/No)
Health Behavior – Use of Health Services	
Traditional Domains	
PCP visit	Visit to PCP (Yes/No), Number in last year (continuous); Reason
Hospitalization	Hospitalization (Yes/No); Number in last year (continuous); Reason
ED visit	ED visit (Yes/No); Number in last year (continuous); Reason
RHWP use	Participant (Yes/No)

2.2.3.3 Data Collection

All interviews were conducted in RHWP clinic space or the participant's residence. All areas were private. The interviews were held at a time convenient for the participant. The participant interviews were audio recorded. All interviews were transcribed and checked for accuracy by a research assistant. The demographics, health-related variables, use of RHWP clinic, and REALM-SF score were entered in a Research Electronic Data Capture (REDCap) database created for this study. Study data were collected and managed using REDCap electronic data capture tools hosted at Virginia Commonwealth University. REDCap is a secure, web-based application designed to support data capture for research studies, providing 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources.[94]

2.2.3.4 Data Analysis

A qualitative thematic analysis was performed to identify and categorize themes related to ED utilization and care transition problems. Thematic analysis is a method for identifying patterns or themes within data.[95] The starting point was to become familiar with the data, reading the transcripts, and noting initial ideas. Initial codes, or first cycle codes, were generated to identify features of the data in a systematic fashion across all interviews.[95,96] Codes, or labels, provided descriptive or inferential meaning to the data.[90,96] A code has been defined in qualitative data

analysis as "a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data."[96] Primarily descriptive codes, labels to summarize in a word or short phrase, were used in this study to categorize similar data chunks (e.g. each semi-structured interview question).[96]

After generating initial codes, the codes were collapsed into potential themes. This is referred to as second cycle coding, or grouping first cycle codes into a pattern code or theme.[96] The themes were reviewed to make sure that all data relevant to each theme was included and to checked for their agreement across all interviews.[95] Five interviews, representing a variety of reasons for ED use, were coded by a second researcher. Meetings were held to reach consensus on generated themes. Examples for each theme and the prevalence of each theme throughout the interviews are reported.[95] NVivo software (NVivo 10, QSR International Pty. Ltd), a Computer-Assisted Qualitative Data Analysis Software (CAQDAS), was used to support data management.

Descriptive statistics (means, SD, frequency, %) were used to describe the demographics, health-related variables, use of RHWP clinic, and REALM-SF scores of the participants. SAS for Windows version 9.4 was used for the descriptive analysis (SAS Institute Inc., Cary, NC).

2.2.4 Study Design – Aims 1C – 1E

For Aims 1C-1E, a six month, prospective review of participant charts from RHWP at this low-income, subsidized housing apartment building was proposed in April 2014. The following

section describes the methods for these aims. As work began to address these aims, challenges to achieving the aims as proposed are addressed in this section.

Proposed Aims and Hypotheses

1C: Describe the predisposing (e.g. age, gender, ethnicity/race, education level), enabling (e.g. insurance type, PCP, years of residence, social network, transportation source, telephone access, use of assistive devices, Activities of Daily Living), and need (e.g. number of medications, type and number of chronic conditions, type and number of mental health conditions, substance abuse history) characteristics and use of health services or health behaviors (e.g. ED visits, hospitalizations, PCP visits, use of RHWP clinic) of the RHWP participants. Describe RHWP clinic use and reason for visits (e.g. number of clinic visits per patient, main patient reasons for clinic use (chief complaint)), problems identified (e.g. potentially inappropriate medication use or care transition problem), and services or care coordination provided. Describe patient self-report of ED use (e.g. number of ED visits per patient, main reasons for ED visit, care provided in the ED, and outcome of ED visit), patient's scores on validated tools (e.g. Geriatric Depression Scale), and modified tools (e.g. Care Coordination Measurement Tool).

1D: Examine the association between predisposing, enabling, and need characteristics and health behaviors of the RHWP participants with the occurrence of care transition problems.

HA1: Patients with a higher number of medications will be more likely to experience a care transition problem.

HA2: Patients with a lack of follow-up with their PCP will be more likely to experience a care transition problem.

HA3: Patients with a higher number of chronic conditions will be more likely to experience a care transition problem.

HA4: Patients who have help or aid in the home will be less likely to experience a care transition problem.

HA5: Patients with the ability to drive will be less likely to experience a care transition problem.

HA6: Patients with higher levels of independence will be less likely to experience a care transition problem.

H07: There will be no difference between other predisposing (age, gender, race/ethnicity, education level), enabling (insurance type, years of residence, telephone access, use of assistive devices), need (mental health conditions, substance abuse history), and health behavior characteristics (RHWP use, hospitalizations, ED visits) with the presence of a care transition problem.

1E: Examine the association between predisposing, enabling, and need characteristics and health behaviors of the RHWP participants with ED use.

HA8: Patients with a hospitalization within the past six months will be more likely to have an ED visit than those who were not hospitalized.

HA9: Patients with diabetes will be more likely to have an ED visit than those without diabetes.

HA10: Patients with heart disease will be more likely to have an ED visit than those without heart disease.

HA11: Older patients without a PCP are more likely to have an ED visit than those with a PCP.

HA12: Patients without help or aid in the home will be more likely to have an ED visit than those who do.

HA13: Older patients will be more likely to have an ED visit than younger patients.

HA14: Patients with a higher GDS score will be more likely to have an ED visit than those with a lower GDS score.

H015: There will be no difference between other predisposing (gender, race/ethnicity, education level), enabling (insurance type, years of residence, transportation source, telephone access, use of assistive devices, Activities of Daily Living score), need (number of medications, substance abuse history), and health behavior characteristics (PCP visit, RHWP use) and the presence of an ED visit.

2.2.4.1 Data Source

For Aims 1C-1E, a six month (January 1, 2014- June 30, 2014) prospective chart review was proposed. An existing RHWP database was used as the data source for these aims. The data set contained information from RWHP intake forms, activities of daily living, and RWHP Care Coordination Tool (CCT). Variable inclusion in this study was limited by the information in the existing data set. The proposed outcome variables of a care transition problem and ED use were not clearly operationalized in the research proposal and data was not available to reliably measure these variables. Thus, not all proposed variables and methods were used. The existing

data set inclusion criteria were RHWP participants ≥ 18 years old, ≥ 1 RHWP visit in 2014, and with a completed CCT. The time period of visits with a completed CCT ranged from the start of CCT use in February - July and September - December 2014. No visits with a completed CCT occurred in August of 2014 due to a renovation of the RHWP clinic space. The time frame of this research was expanded to include all of 2014 to correspond with the time frame of the existing database.

2.2.4.2 Variables

The variables included in this study were based upon information available in an existing data set. The proposed methods included information from intake forms, the CCT, progress notes, and from an ED visit form. The progress note information was the proposed source for problem identification (e.g. potentially inappropriate medication use or care transition problems (dependent variable Aim 1D)). The ED visit form was the proposed source of information about ED use (dependent variable Aim 1E). Data was not available from these forms in the existing data set. Therefore, these variables were not included. The following table (Table 10) shows the proposed variables and lists the availability of the information in the existing data set.

Table 10. Proposed variable collection and variables in existing RHWP data set

Proposed Variables	**Definition**	**Variable in Existing Data Set**
Patient Intake Form		
Predisposing- Traditional Domain		
Age	Years	Yes
Gender	Male/Female	Yes
Race/Ethnicity	Caucasian/African-American/Native American/Asian/Hispanic/Other	Yes

Education	Years of education; GED (Yes/No)	Yes
Enabling – Traditional Domain		
Insurance	Medicare/Medicaid/ Medicare-Medicaid Dual Eligible/Other	Yes
Primary care provider (PCP)	Yes/No	Yes
Years of residence	Number of years residing in the apartment building	Yes
Social network	Relationship of contact (if need something or are sick); Help or aid in the home (Yes/No)	Yes
Enabling- Vulnerable Domain		
Transportation source	Ability to drive (Yes/No); If No, method of transportation	Yes
Telephone access	Telephone (Yes/No); Cell phone (Yes/No)	No
Assistive devices (walker, cane, wheelchair)	Yes/No; Type	Yes
Activities of daily living (ADL): bathing, dressing, toileting, transferring, continence, feeding	Independent/Dependent	Yes
Need- Traditional Domain		
Past Medical History: Alzheimer's disease or problems with your memory; ankle/leg swelling; arthritis; asthma; COPD; cancer; CAD / heart disease MI / heart attack (year); high blood pressure/hypertension; high cholesterol; stroke; diabetes/high blood sugar; seizures; visual impairment; hearing impairment; kidney impairment; loss of feeling/numbness burning in legs or feet; osteoporosis; Parkinson's disease; sciatica or chronic back pain; diarrhea; GERD; constipation; urinary incontinence; inflammatory bowel; thyroid problem; weight loss > 10 lb. in last year (intentional); headaches / migraines; insomnia	Yes/No; Type and number of chronic conditions	Yes
Medication use	Number of medications	No
Need- Vulnerable Domain		
Past mental health history:	Yes/No;	Yes

Schizophrenia; bipolar disorder; depression	Type and number of mental health conditions	
Substance abuse history	Alcohol Consumption (Yes/No); Amount of alcohol per week; Illicit drugs (Yes/No); Description of illicit drugs	Yes
Health Behavior (Use of Health Services)		
Hospital admission	Date of last admission; Hospital; Reason; Number of visits in last 6 months	Yes
ED visits	Date of last ED visit; Hospital; Reason	Yes (on intake form only)
PCP visits	Date of last PCP visit	Yes
	Reason	No
	Number of visits	No
RHWP use	Number of clinic visits	Yes
Progress Note for Clinic Visits		
Date of visit	Date	No
Chief complaint	Text	No
Subjective	Text (includes social history)	No
Objective	General appearance and physical findings: vitals (BP, pulse, weight, pain (vitals flow sheet);point of care test (BG, A1C, lipids - point of care flow sheet); targeted exam based on symptoms	No
Assessment	Text	No
Plan	Text	No
Targeted counseling	Inhaler/glucometer use	No
Return to clinic	Number of weeks	No
Professions involved	Pharmacy/Nursing/Social Work	No
ED Visit Form		
Date of ED visit	Date	No
Description of reason for visit	Text	No
ED visited	Name of hospital	No
Care provided in ED	Text	No
Outcome of ED visit	Text	No
Other notes	Text	No

The proposed methods included collecting information from the Medication Discrepancy Tool.[97] The MDT examines causes and contributing factors of medication discrepancies from a patient level (e.g. patient did not fill prescription), system level (e.g. conflicting information from different informational sources or confusion between brand and generic names), and resolution of the discrepancy (e.g. encouraged patient to call PCP or specialist about the problem).[97] This tool was not adopted for use in the RHWP. In addition, a checklist to determine if a potentially inappropriate medication was present and the participant's number of potentially inappropriate medications based upon the Beers Criteria for Inappropriate Medication Use in Older Adults was proposed.[98] Medication lists were not available in the existing data set, so this was not included in the study. Validated tools, such as the Geriatric Depression Scale[99], were not a part of this existing data set and therefore, not included.

Information from a modified form for the RHWP clinic, the RWHP Care Coordination Tool (CCT), was collected in the existing data set. In order to measure care coordination activities and outcomes of the RHWP, this adapted tool was developed from the Medical Home Care Coordination Measurement Tool (CCMT) used in pediatric clinics published in the Agency for Healthcare Research and Quality Care Coordination Measures Atlas.[100] Information collected from the RHWP Care Coordination Tool (CCT) included care coordination activities needed, activities performed to fulfill care coordination needs, faculty type involved in the process, total faculty time, outcomes prevented, and outcomes that occurred due to care coordination activities. The variables collected from the CCT form are described in Table 11 and align with what was proposed.

Table 11. Variables collected from the RHWP Care Coordination Tool (CCT)	
CCT Variable	**Description**
Faculty team composition	Nursing (NP) Pharmacy (PharmD) Medicine (MD) Social Work (SW) Psychology (Doctoral) Gerontology
Faculty team visit time	Number (minutes)
Care coordination activities/needs categories	Type of care coordination activities/needs, Number of care coordination activities/needs
Make appointments Follow-up/Referral management Order: Prescriptions/Prescription delivery; Supplies (e.g. glucometer, walker); Home health care services; Laboratory tests; Other Reconcile discrepancies: Medication-related; Adherence issues; Other Education/Counseling Coordination of social services: Agencies (e.g. SSI); Insurance; Transportation; Other Disease management Disease monitoring Medication management Home visit Other	

Activity performed to fulfill care coordination needs categories	Activity to fulfill care coordination needs, Number of care coordination activities to fulfill needs
Face-to-face discussion Telephone discussion Electronic (e-mail) contact Faxed communication Written report Form processing Chart review Patient-focused research Develop/modify written care plan Meeting/case conference Monitoring Social work assessment Social work enrollment Patient education/counseling (face-to-face): Psychosocial support; Practical concerns (e.g. financial, insurance, transportation); Family/support system concerns; Emotional concerns (e.g. distress, depression, anxiety); Medication-related; Disease-related; Other Home visit Other	
Outcomes prevented categories	Type of outcome prevented, Number of outcomes prevented, Degree of certainty
ER visit Subspecialist visit Hospitalization (admission) Visit to PCP office/clinic Lab/X-ray Specialized therapies (PT, OT, etc.) Inappropriate medication use Adverse drug event Nursing home stay Other	

Outcomes occurred categories	Type of outcome occurred and number of outcomes occurred
Advised family/patient on home management	
Patient knowledge or skill	
Referral to ER	
Referral to subspecialist	
Referral for hospitalization	
Referral for PCP office visit	
Referral to lab/ x-ray	
Referral to community agency	
Referral to psych. (LCSW, LMFT, LPC, etc.)	
Referral to specialized therapies	
Referral to social work on site	
Referral to APS	
Referral to support group	
Ordered prescription, equipment, etc.	
Reconciled discrepancies (including missing data, miscommunications, adherence issues, medication issues)	
Reviewed labs, specialist reports, etc.	
Set up family/caregiver meeting	
Advocacy for patient	
Met patient's immediate needs, questions, concerns	
Unmet needs	
Not applicable/don't know	
Outcome pending	
Other	

2.**2.4.3 Data Analysis**

Aim 1C

Descriptive statistics (means, SD, frequency, %) were used to characterize the predisposing (e.g. age, gender, ethnicity/race, education level), enabling (e.g. insurance type, PCP, years of residence, social network, transportation source, telephone access, use of assistive devices, Activities of Daily Living), and need (e.g. type and number of chronic conditions, type and number of mental health conditions, substance abuse history) factors and use of health services

or health behaviors (e.g. ED visits, hospitalizations, PCP visits, use of RHWP clinic) of the RHWP participants. Descriptive statistics were also reported for the CCT.

Proposed descriptive statistics from the participant's progress note (e.g. number of clinic visits per patient, main patient reasons for clinic use (chief complaint)); from the ED visit form (e.g. number of ED visits per patient, main reasons for ED visit, care provided in the ED, and outcome of ED visit); validated tools (e.g. Geriatric Depression Scale[99]); and summary information from patient visits, including but not limited to problems identified (e.g. potentially inappropriate medication use or care transition problem) are not reported since this information was not available in the existing data set.

Aim 1D

The dependent variable, presence of a care transition problem, was not available in the existing data set. This aim was not addressed.

Aim 1E

The dependent variable, ED use from the ED visit form, was not available in the existing data set. This aim was not addressed.

2.3 Study Design: Aim 2

A cross-sectional research design was proposed to examine patterns of and predictors of ambulance use in the Richmond area. Aims 2A-2E were as follows:

2A: Describe the demographics (age, race, gender) and use characteristics (location of ambulance pick-up, location of transport destination, reason for transport (destination code), date and time of transport, urgent vs. non-urgent) of all ambulance transports in the Richmond area and for all ambulance transports from the low-income, subsidized housing apartment building.

2B: Compare ambulance use before and after the start of the RHWP for older adults at the low-income, subsidized housing apartment building.

2C: Compare use of ambulance services by older adults by zip code to identify areas of high utilization in the Richmond area.

2D: Examine the relationship between demographic (age, race, gender) and utilization variables (reason for transport, date, and time of transport) with non-urgent ambulance transports to the ED.

Information about all 2011-2013 ambulance transports for the city of Richmond reported to the Virginia Department of Health was the intended source of data for these aims. This data source would have allowed for the analysis of utilization of ambulance services before and after the start of the RHWP clinic and allowed for comparisons between this apartment building and the Richmond area ambulance transports. However, data was not available for this aim. Therefore, it was not able to be addressed.

2.4 Study Design: Aim 3

A cross-sectional, retrospective analysis of administrative electronic medical record data and billing records was used to examine Aim 3. The following section describes the methods used for this aim.

Proposed Aims and Hypotheses

3A: Describe demographic and ED visit characteristics for older adults in an urban, safety-net hospital.

3B: Examine the relationship between demographics and ED visit characteristics and zip code of patient residence.

For non-emergent ED visits:

HA27: Patients who live in zip code 23220 with a non-emergent ED visit will be older than those who do not live in zip code 23220.

HA28: Patients who live in zip code 23220 with a non-emergent ED visit will have higher CCI scores than those who do not live in zip code 23220.

HA29: Patients who live in zip code 23220 with a non-emergent ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.

HA30: Patients who live in zip code 23220 with a non-emergent ED visit will have higher total costs than those who do not live in zip code 23220.

HA31: Patients who live in zip code 23220 with a non-emergent ED visit will have a higher disease count than those who do not live in zip code 23220.

H032: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, visit procedures, disposition, and number of prescribed medications in a non-emergent ED visit by patients who live in zip code 23220.

For emergent but primary-care treatable ED visits:

HA33: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will be older than those who do not live in zip code 23220.

HA34: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will have higher CCI scores than those who do not live in zip code 23220.

HA35: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.

HA36: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will have higher total costs than those who do not live in zip code 23220.

HA37: Patients who live in zip code 23220 with an emergent, but primary care treatable ED visit will have a higher disease count than those who do not live in zip code 23220.

H038: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, visit procedures, disposition, and number of prescribed medications in an emergent, but primary care treatable ED visit by patients who live in zip code 23220.

For emergent, ED care needed, but preventable/avoidable ED visits:

HA39: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will be older than those who do not live in zip code 23220.

HA40: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will have higher CCI scores than those who do not live in zip code 23220.

HA41: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.

HA42: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will have higher total costs than those who do not live in zip code 23220.

HA43: Patients who live in zip code 23220 with an emergent, ED care needed, but preventable/avoidable ED visit will have a higher disease count than those who do not live in zip code 23220.

H044: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, visit procedures, disposition, and number of prescribed medications in an emergent, ED care needed, but preventable/avoidable ED visit by patients who live in zip code 23220.

3C: Examine the relationship between demographics, ED visit characteristics, and billing costs.

All patients aged ≥ 65 years old using VCUHS ED:

HA45: Living in the 23220 zip code area will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA46: Increasing age will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA47: Larger CCI scores will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA48: Arrival to the ED via ambulance will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA49: Higher total disease count will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA50: Higher total visit procedures will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

H051: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, disposition, and number of prescribed medications on total ED billing costs.

Only patients living in zip code 23220 using VCUHS ED:

HA52: Participation in RHWP will be a significant negative predictor of total ED billing costs, while controlling for all other variables in the model.

HA53: Increasing age will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA54: Larger CCI scores will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA55: Arrival to the ED via ambulance will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA56: Higher total disease count will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA57: Higher total visit procedures will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

H058: There will be no effect of gender, race/ethnicity, payment source, visit diagnosis, disposition, NYU ED algorithm category, and number of prescribed medications on total ED billing costs.

2.4.1 Data Source

The source of data for these aims was electronic medical record data from 2010-2013 from VCUHS ED (Cerner) and billing records (IDX GE). The year 2010 was chosen to identify two years of data before the start of the RHWP clinic. The year 2013 was the latest year available at the time of data retrieval. VCUHS is an urban, safety-net, level 1 trauma, academic medical center in central Virginia. Data was abstracted from VCUHS electronic medical and billing records by the VCU Biomedical Informatics Core, VCU Center for Clinical and Translational Research.

2.4.2 Inclusion and Exclusion Criteria

ED visit information from 2010 - 2013 for community-dwelling older adults (≥ 65 years old) from an urban, academic medical center was included in this study. Only ED visit (encounter type or encounter type class variable in the dataset) information was included. Non-community-dwelling older adult ED visits were excluded. In order to determine community-dwelling status after examination of the data set, patients' ED visits were excluded based on the following criteria:

1. If address was not indicative of a community-dwelling residence (e.g. skilled nursing facility or assisted living facility),
2. If address corresponded to a correctional facility,
3. If the admit source or mode was a transfer from another health care facility (e.g. another hospital) or court/law enforcement,
4. If address was not complete and community-dwelling status could not be confirmed (e.g. only provided an apartment number, P.O. Box, trailer number, or missing), and
5. If address indicated that the patient was under the care of another entity (e.g. c/o individual or business name).

2.4.3 Variables

The following variables were abstracted from 2010 – 2013 VCUHS ED electronic medical and billing records for patients ≥ 65 years old: age, gender, race, ethnicity, payment source (e.g. Medicare), address, admit mode of arrival and type, visit details (encounter type, primary

diagnosis, procedures, problems, medications ordered, discharge disposition), and total ED costs. The following sections describe the variables examined and created to address Aims 3A – 3C.

2.4.3.1 Age

Age was a continuous variable (years). The distribution of the age variable was examined. Age was categorized into quartiles for analysis. The age quartile (Q) distribution was: 65-67 years (Q1), 68-71 years (Q2), 72-78 years (Q3), and 79- 103 (Q4).

2.4.3.2 Gender

Gender was a dichotomous variable, defined as male or female.

2.4.3.3 Race

Race was a categorical variable. The categories were: White, Black or African-American, American Indian/Alaskan, Asian, Native Hawaiian/Other Pacific Islander, Other, and Unknown/Patient Refused/Patient Unable to Communicate (i.e. Unknown). Due to small sample size, American Indian/Alaskan and Native Hawaiian/Other Pacific Islander were collapsed into the Other race category. Thus, the final descriptive race categories were: White, Black or African-American, Asian, Other, and Unknown.

2.4.3.4 Ethnicity

Ethnicity was a categorical variable. The categories for ethnicity were: Hispanic-Latino-Spanish Origin, Not Hispanic-Latino-Spanish Origin, Unknown/Unable to Communicate, and N/A. Unknown/Unable to Communicate and N/A were collapsed into an Unknown Category. The final ethnicity categories were: Hispanic-Latino-Spanish Origin; Not Hispanic-Latino-Spanish Origin; and Unknown.

2.4.3.5 Payment Source

Payment source was determined by the variable Primary Health Plan Name in the dataset. The primary health plan names were coded into the following categories: Medicare, Medicaid, Self-Pay, Indigent, Virginia Coordinated Care (VCC), VA/Tricare, and Other. Primary health plan names with a status of pending (e.g. eligibility pending Medicaid and Indigent Care Pending/Denial) were coded as missing due to unknown status. The primary health plan names included in each category are provided in Appendix 4. Patients could have more than one type of payment. Combinations of payment types included: Medicaid and Other; Medicaid and Tricare/VA; Medicare and Medicaid; Medicare, Medicaid, and Other; Medicare and Other; and Medicare and Tricare/VA. Due to small sample size some of the categories were collapsed. Thus, the final eight collapsed categories for payment source were: Medicare, Medicaid, Medicare and Medicaid, Medicare and Other, Self-pay, VCC, Indigent, and Other.

2.4.3.6 Mode of Arrival to ED

The mode of arrival to the ED was a categorical variable. The categories for arrival mode were via ambulance (emergency medical services (EMS)), helicopter, and self-private transportation.

2.4.3.7 Primary Diagnosis

Primary diagnosis variable was a categorical variable. It was defined as the ICD-9-CM code assigned to the ED visit. The 20 most frequently coded reasons, when sample size was large enough, for the ED visit were reported.

2.4.3.8 Charlson Comorbidity Index (CCI) Score

The Charlson Comorbidity Index (CCI) was used as a measure of comorbidity. The CCI has been validated in hospital patients and used to predict one year mortality. The CCI is a weighted index that incorporates both the number of comorbid diseases and the severity of the disease.[101] A higher CCI score was related to higher mortality rates at one year compared to lower CCI scores.[101] The weights and comorbid conditions used to calculate the CCI score are provided in Table 12. The Dartmouth-Manitoba (Romano) CCI adaptation which incorporates ICD-9-CM codes for identifying comorbid conditions was used.[102] Patient problems in the data were defined with a description and either an ICD-9-CM or Systematized Nomenclature of Medicine-Clinical Terms (SNOMED CT) code. SNOMED CT codes were converted to an appropriate ICD-9-CM code using the Unified Medical Language System (UMLS) cross map.[103] The distribution of the CCI score variable was examined. The CCI scores were categorized into 5 categories based on the variable's distribution: 0, 1, 2, 3, or ≥ 4.

Table 12. Charlson Comorbidity Index score weights and conditions[101]	
Weights for diseases	**Conditions**
1	Myocardial infarction Congestive heart failure Peripheral vascular disease Cerebrovascular disease Dementia Chronic pulmonary disease Rheumatologic disease Peptic ulcer disease Mild liver disease Diabetes – mild to moderate
2	Hemiplegia or paraplegia Diabetes with chronic complications Renal disease Any malignancy, including lymphoma and leukemia
3	Moderate or severe liver disease
6	Metastatic solid tumor AIDS

2.4.3.9 Total Disease Count

The total disease count variable was created from the sum of the ICD-9-CM codes per ED visit. The distribution of the total disease count variable was examined. Total disease count was categorized into quartiles for analysis. The quartile (Q) distribution for the total disease count was: 1-3 (Q1), 4-6 (Q2), 7-9 (Q3), and ≥ 10 diseases (Q4).

2.4.3.10 Potentially Inappropriate Medication (PIM) Ordered in ED Visit

The proposed variable, total number of discharge medications prescribed after the ED visit, was not used due to not being available in the dataset. Home medications were not available in the dataset. The medication variable provided in the data set was Order Mnemonic- Ingredient. This was defined in the Cerner data dictionary as text representing the name by which an ingredient was ordered in the ED. All of the medications ordered were not relevant for analysis. For

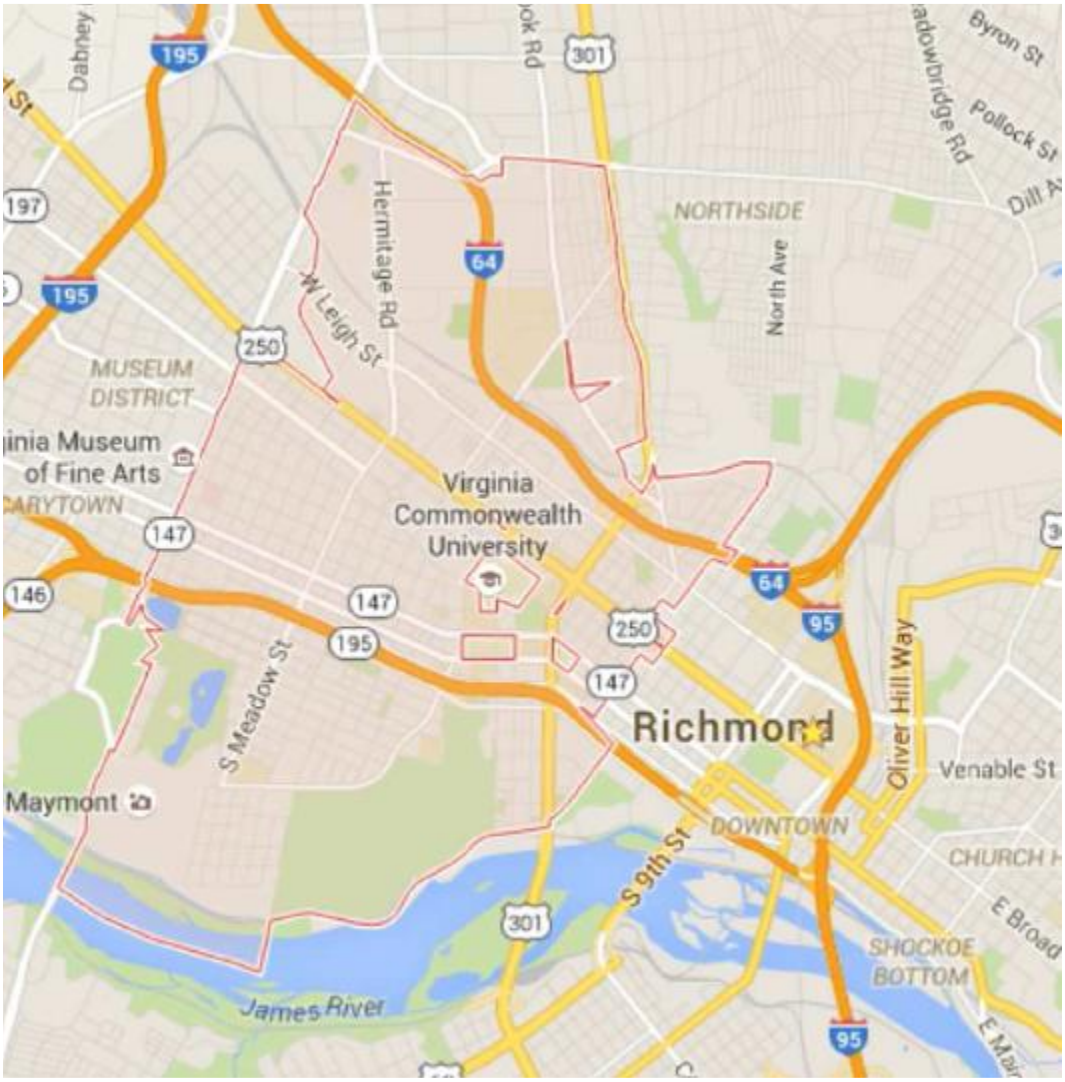
example, sodium chloride 0.9% was a medication ordered in the dataset. Therefore, to provide relevant information about medications ordered in the ED, the medication ordered in the ED variable was examined to identify ED PIM use. The 2012 American Geriatrics Society Beers Criteria for Inappropriate Medication Use in Older Adults was used to identify medications to avoid in older adults regardless of disease states or conditions.[98] The list provides rationale, recommendation (e.g. avoid), quality of evidence (e.g. low, moderate, high), and strength of recommendation (e.g. insufficient, weak, strong).[98] Examples of medications to avoid are long-acting benzodiazepines such as clonazepam, pain medications such as meperidine, and first-generation antihistamines with anticholinergic properties such as hydroxyzine. [98] All ED visits with medications ordered in the ED were examined; however, not all ED visits had medications ordered. This was double checked by the encounter identifier unique to each ED visit. First, a variable was created to identify PIM ordered in the ED visit (yes/no) from the medication ordered variable in the data set. Next, the sum of PIMs used per visit was calculated. The number of PIMs per visit was collapsed into four categories: 0, 1, 2, and 3-5 PIM medications.

2.4.3.11 Discharge Disposition

Discharge disposition variable was a categorical variable. The discharge dispositions were: Home or self-care (Routine), Expired, Left against medical advice (AMA), Eloped without notice AMA, Left before clinical evaluation, Other facility/nursing home, and Redirected to L&D- D/C. Left against medical advice and Eloped without notice AMA were collapsed into one category – Left AMA. Redirected to L&D-D/C was recoded as Other facility/nursing home. The final categories for discharge disposition were: Home or self-care, Expired, Left AMA, Left before clinical evaluation, and Other facility/nursing home.

2.4.3.12 Zip Code 23220

A dichotomous variable was created to identify ED visits from zip code 23220 (Yes/No). The map below shows zip code 23220 (red shaded area) in relation to VCUHS ED (yellow star).



2.4.3.13 Health Care "Hot Spot" Residence

A dichotomous variable was created to identify ED visits from the address of the low-income, subsidized housing apartment building in this study. It is considered a health care "hot spot" (i.e. geographic area of high health care utilization) due to high ambulance use in 2012. The variable was defined as Yes/No.

2.4.3.14 Year of ED Visit

The year of ED visit was created from the date of admission. This variable was added to the final methods to adjust for year of ED visit. The variable was categorical and defined as 2010, 2011, 2012, and 2013.

2.4.3.15 Frequent ED User

The total number of visits per unique medical record number by year was determined. Based on subsequent literature review, frequent ED user was identified as a variable needed in the final model.[13,42] The inclusion of this variable helps examine the relationship of frequent ED use with total ED costs and helps to characterize if frequent ED users are more likely to have a zip code of 23220 (includes health care hot spot low-income, subsidized housing apartment building). A frequent ED user was defined as having 4 or more ED visits[33-36] over any one year in the study (Yes/No).

2.4.3.16 Type of ED Visit (NYU ED Algorithm)

The NYU ED algorithm, described in the literature review section, was used to classify ED visits by ICD-9-CM primary diagnosis code.[60-62] The initial categories of ED visits based on the algorithm were:

1. Non-emergent
2. Emergent, primary care treatable
3. Emergent, ED care needed, preventable/avoidable
4. Emergent, ED care needed, not preventable/avoidable
5. Injury
6. Mental health related
7. Alcohol related
8. Drug related (excluding alcohol)
9. Not in a special category and not classified

The proposed analysis by ED visit categories of non-emergent, emergent but primary care treatable, and emergent, ED care needed but preventable/avoidable ED visits has not been previously validated in the literature to predict hospitalizations and mortality. Thus, the method used in validation and other studies was used to classify ED visits into emergent, non-emergent, and intermediate visits for the descriptive analyses.[60,63,64] Non-emergent and emergent ED visits were examined in the bivariate and multivariable analyses.

The validated NYU ED algorithm assigns the ICD-9-CM diagnosis code for the ED visit a probability (0-1) of falling into the following four ED visit types: non-emergent, emergent but primary care treatable, emergent ED care needed but preventable/avoidable, or emergent ED care needed not preventable/avoidable. [64] The validated NYU algorithm used these probabilities to then categorize ED visits into non-emergent, emergent, and intermediate ED visit types. [64] The validated criteria used for the categorization of ED visits are defined in Table 13.

Table 13. Categorization of ED visits by NYU ED Algorithm probabilities[60,63,64]

Type of ED visit	Condition for Type of ED visit
Non-emergent	If Σ (non-emergent + emergent, primary care treatable) > 0.50
Emergent	If Σ (Emergent, ED care needed, preventable/avoidable + Emergent, ED care needed, not preventable/avoidable) > 0.50
Intermediate	If both Non-emergent and Emergent = 0.50

2.4.3.17 Total ED Costs

Total costs for each ED visit were provided from the billing database at VCUHS. These costs are a sum of the direct and indirect costs related to the individual ED visit. Costs were adjusted for inflation using the Consumer Price Index (CPI) for Medical Care Services and reported in 2014 dollars.[48, 49] The method provided by the United States Department of Labor, Bureau of Labor Statistics was used for adjustment.[104,105] The total costs were escalated by the percent change in the CPI for Medical Care Services over the two time periods. The equation below was used to determine the percent change.

$$\text{Index point change} = (\text{CPI}_{2014} - \text{CPI}_{\text{year x}})$$

$$\text{Percent change} = (\text{Index point change}/\text{CPI}_{\text{year x}}) * 100$$

The percent changes used for total cost adjustment to 2014 dollars by year of ED visit were: 2010: 1.1303, 2011: 1.0967, 2012: 1.0555, and 2013: 1.0237.

2.4.3.18 Proposed Variables Not Used

Two variables, procedures in the ED and RHWP participant, were proposed for use in this study. After including only ED encounters in the final set, only nine ED encounters had an associated procedure performed in the ED. A variable for RHWP participants (Yes/No) was created and evaluated for use. It was determined that both ED procedures and number of RHWP participant ED encounters (n=7 emergent ED visits and n=31 non-emergent ED visits) had too small of a sample size for inclusion in this study.

2.4.4 Data Analysis

The following section describes the methods used in data analysis for Aim 3.

2.4.4.1 Aim 3A

3A: Describe demographics and ED visit characteristics for older adults in an urban, safety-net hospital.

Descriptive statistics (means, SD, frequencies, %) were used to describe demographics (age, gender, race, ethnicity, payment source, CCI score, total disease count) and ED visit characteristics (mode of arrival, primary diagnosis (ICD-9 CM), PIM ordered in the ED, PIM number per ED visit, year of visit, discharge disposition, NYU ED visit category, frequent ED use, total ED costs). Descriptive statistics are reported by the following groups: all older adults, zip code 23220, and health care hot spot address. Descriptive statistics are also reported by NYE ED non-emergent, emergent, and intermediate visit categories. Proposed variables not reported

were ED visit procedures and RHWP participants after examining the data set for reasons previously described.

2.4.4.2 Aim 3B

The proposed analysis used three different logistic regression models by NYU ED visit category (non-emergent, emergent but primary care treatable, or emergent, ED care needed, but preventable/avoidable ED visit) with a dependent variable of zip code 23220 (Yes/No). Further review of the validation of the NYU ED algorithm and evaluation of the data supported the categorization of ED visits by non-emergent, emergent, and intermediate ED visits as described in the previous section.[60,63,64] The small number of intermediate ED visits (n=115) limited its use in the final bivariate and multivariate analysis. Aim 3B and its updated hypotheses to reflect the variables described in section 2.4.3 are presented below.

3B: Examine the relationship between demographics and ED visit characteristics and zip code of patient residence.

For non-emergent ED visits:

HA1: Patients who live in zip code 23220 with a non-emergent ED visit will be older than those who do not live in zip code 23220.

HA2: Patients who live in zip code 23220 with a non-emergent ED visit will have higher CCI scores than those who do not live in zip code 23220.

HA3: Patients who live in zip code 23220 with a non-emergent ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.

HA4: Patients who live in zip code 23220 with a non-emergent ED visit will have higher total costs than those who do not live in zip code 23220.

HA5: Patients who live in zip code 23220 with a non-emergent ED visit will have a higher disease count than those who do not live in zip code 23220.

H06: There will be no effect of gender, race, ethnicity, payment source, discharge disposition, PIM ordered in the ED, health care hot spot address, frequent ED use, and year of ED visit in a non-emergent ED visit by patients who live in zip code 23220.

For emergent ED visits:

HA7: Patients who live in zip code 23220 with an emergent ED visit will be older than those who do not live in zip code 23220.

HA8: Patients who live in zip code 23220 with an emergent ED visit will have higher CCI scores than those who do not live in zip code 23220.

HA9: Patients who live in zip code 23220 with an emergent ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.

HA10: Patients who live in zip code 23220 with an emergent ED visit will have higher total costs than those who do not live in zip code 23220.

HA11: Patients who live in zip code 23220 with an emergent ED visit will have a higher disease count than those who do not live in zip code 23220.

H012: There will be no effect of gender, race, ethnicity, payment source, discharge disposition, PIM ordered in the ED, health care hot spot address, frequent ED use, and year of ED visit in a non-emergent ED visit by patients who live in zip code 23220.

The dependent variable in this aim was zip code 23220 (yes/no). For aim 3B, the data set was split into non-emergent and emergent ED visits for analysis. Bivariate and multivariable analyses were conducted on the split data sets. The results are reported by non-emergent and emergent ED visits. Bivariate statistics (t-tests for continuous variables, chi-square for categorical variables) were used to explore associations between independent variables and those who live in zip code 23220 compared to those who do not. Logistic regression was used to examine the crude association (bivariate analysis) between the independent variables and zip code 23220. Two full prediction multivariable logistic regression models were used (one for non-emergent and one for emergent ED visit data) to examine the relationship between demographics (age, gender, race/ethnicity, payment source, CCI score, total disease count, health care hot spot address) and ED visit characteristics (mode of arrival, discharge disposition, PIM ordered in the ED, frequent ED use, year of ED visit, and total costs) with zip code 23220. Multicollinearity was assessed. Unadjusted and adjusted odds ratios and 95% confidence intervals are reported. The *a priori* significance level was $p < 0.05$. SAS for Windows version 9.4 was used for data analysis (SAS Institute Inc., Cary, NC).

2.4.4.3Aim 3C

The proposed methods used two different multivariable linear regression models, one with the full data set of all older adults and one with only those residing in zip code 23220. As described above, it was determined that ED procedures and number of RHWP participant ED encounters had too small of a sample size for inclusion in this study. Likewise, application of the NYU ED algorithm and evaluation of the data supported the categorization of ED visits by non-emergent, emergent, and intermediate ED visits as described in section 2.4.3 and Aim 3B. [60,63,64] As in aim

3B, the small number of intermediate ED visits (n=115) limited their use. Thus, all ED visits in this aim included the non-emergent and emergent ED visits classified by the validated NYU ED algorithm. A subgroup analysis of non-emergent and emergent ED visits for zip code 23220 was performed. Aim 3C and its updated hypotheses (to reflect the variables described in section 2.4.3) are presented below.

3C: Examine the relationship between demographics, ED visit characteristics, and billing costs.

All ED visits (emergent and non-emergent):

HA13: Zip code 23220 will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA14: Increasing age will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA15: Larger CCI scores will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA16: Arrival to the ED via ambulance will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA17: Higher total disease count will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

H018: There will be no effect of gender, race, ethnicity, payment source, discharge disposition, PIM ordered in the ED, health care hot spot address, frequent ED use, NYU ED algorithm category, and year of ED visit on total ED costs.

Zip code 23220 ED visits (emergent and non-emergent):

HA19: Increasing age will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA20: Larger CCI scores will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA21: Arrival to the ED via ambulance will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

HA22: Higher total disease count will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.

H023: There will be no effect of gender, race, ethnicity, payment source, discharge disposition, PIM ordered in the ED, health care hot spot address, frequent ED use, NYU ED algorithm category (non-emergent or emergent), and year of ED visit on total ED costs.

The dependent variable in this aim was total ED costs adjusted to 2014 United States dollars ($). The data set was split into the following two groups: All non-emergent and emergent ED visits and non-emergent and emergent ED visits from zip code 23220 only. Bivariate and multivariable analysis were conducted on the split data sets. The results for each data sets are reported separately.

Bivariate statistics (ANOVA, unadjusted regression) was used to explore association between independent variables and total ED costs. Multivariable linear regression was proposed to examine the relationship between demographics and ED visit characteristics with billing costs.

The dependent cost variable was assessed for need of transformation. Dummy variables were created for categorical variables. Multicollinearity, residual, and outlier diagnostics were performed. Cost variables are often highly skewed to the right. Log transformation of the cost variable will deal with skewness; but, interpretation of log scale cost results are of little interest.[106] Retransformation biases can arise if the assumption of homoscedasticity (equal error variance) is violated.[106-108] Often the variance increases as the mean cost increases.[106-108] Thus, generalized linear model (GLM) regression was chosen to model the relationship with the independent variables and total ED costs. GLM regression does not require normal distribution of the cost data and can correct for heteroscedasticity (unequal error variance).[106-108] GLM (PROC GENMOD) with gamma distribution and log link was used. The *a priori* significance level was $p < 0.05$. SAS for Windows version 9.4 was used for data analysis (SAS Institute Inc., Cary, NC).

2.5 Summary of Data Analysis

A summary of the data analysis plan for Aims 1 and 3 is presented in Table 14.

Table 14. Summary of data analysis	
Study aim	**Data analysis**
Aims 1A and 1B	Qualitative thematic analysis Descriptive statistics: mean (SD), range and frequency (%)
Aim 1C	Descriptive statistics: mean (SD), range and frequency (%)
Aim 3A	Descriptive statistics: mean (SD), range and frequency (%)
Aim 3B	Two groups: Non-emergent and Emergent ED visits Descriptive statistics: mean (SD), range and frequency (%) Bivariate analysis: t-tests, chi-square, unadjusted logistic regression Multivariable analysis: adjusted multivariable logistic regression
Aim 3C	Two groups: All (Non-emergent and Emergent) ED visits and Non-emergent and Emergent ED visits from zip code 23220 only Descriptive statistics: mean (SD), range and frequency (%) Bivariate analysis: ANOVA, unadjusted generalized linear model regression Multivariable analysis: adjusted generalized linear model regression

Chapter 3: Results

3.1 Aims 1A and 1B

A total of fourteen residents participated in interviews. An additional twenty residents were screened for eligibility. Twelve residents did not have an ED visit within the 30 day time limit for eligibility, seven residents were unreachable after several attempts, and one resident did not want to sign informed consent documents for participation. Recruitment began in May of 2014 and ended in May of 2015. Thirteen of the interviews were conducted in private clinic space on the first floor of the apartment building and one interview was conducted in a resident's apartment at his/her request. Saturation was examined for all questions in the interviews. Some interview questions achieved saturation (e.g. lack of a personal health record, lack of a care plan) and others did not reach saturation due to the variability of responses for some questions (e.g. individual reasons for ED use and ED experience).

The mean age of participants was 65.7 years old (SD 12.3). Only one participant was younger than 60 years and disabled. The majority were female (57.1%), African-American (78.6%), had a yearly income between $10-19,999 (58.3%), and at least some college (57.1%). Even though 10 of 14 participants had a high school/GED or higher level of education completed, only 5 of 14 participants scored at a ninth grade or higher reading level on the REALM-SF. Only one participant did not have a PCP. Medicare and Medicare-Medicaid insurance were the most

common among the participants. Most participants did not have anyone to help with their care in the home (78.6%) or a regular source of transportation (64.3%). The majority of participants were taking 5-9 daily medications and did not report having a mental health condition or a history of substance abuse. The participants' mean number of chronic conditions was 3.7 (SD 1.3). Predisposing, enabling, and need factors of interview participants are summarized in Table 15.

Table 15. Predisposing, enabling, and need factors of interview participants (n=14)	
Variable	
Predisposing – Traditional Domain	**Mean (SD), Range or n (%)**
Age	65.7 (12.3), 27-78
Age by category	
< 65 years	4 (28.6)
65-69 years	6 (42.9)
≥ 70 years	4 (28.6)
Gender	
Female	8 (57.1)
Male	6 (42.9)
Marital status	
Divorced	7 (50.0)
Never married	6 (42.9)
Married	1 (7.1)
Race/Ethnicity	
African-American	11 (78.6)
Caucasian	2 (14.3)
Other	1 (7.1)
Highest level of education completed	
5 – 8 years	4 (28.6)
High school or GED	2 (14.3)
Some college	6 (42.9)
College graduate	2 (14.3)
Predisposing – Vulnerable Domain	
Health literacy – REALM-SF score	
≤ 3rd grade	1 (7.1)
4th-6th grade	3 (21.4)
7th-8th grade	5 (35.7)
≥ 9th grade	5 (35.7)
Enabling – Traditional Domain	
Regular PCP	13 (92.9)

Health insurance	
Medicare	6 (42.9)
Medicaid	3 (21.4)
Medicare-Medicaid	5 (35.7)
Yearly income (n=12)	
< $9,999	5 (41.7)
$10,000 – 19,999	7 (58.3)
Anyone to help with care	3 (21.4)
Enabling- Vulnerable Domain	
Regular source of transportation	5 (35.7)
Telephone	3 (21.4)
Cell phone	13 (92.9)
Need – Traditional Domain	
Number of medications	8.3 (2.3), 4-12
Less than 5	1 (7.1)
5 to 9	9 (64.3)
10 or more	3 (21.4)
Unknown	1 (7.1)
Number of chronic conditions	3.7 (1.3), 2-5
2	3 (21.4)
3	4 (28.6)
4	1 (7.1)
5	6 (42.9)
Need – Vulnerable Domain	
Number of mental health conditions	0.3 (0.5), 0-1
0	10 (71.4)
1	4 (28.6)
History of substance abuse	3 (21.4)

All of the participants reported visiting a PCP in the last year, even though one participant was currently without a PCP. Participants had a mean of 6.2 PCP visits (SD 6.5) and 2.8 ED visits (SD 5.0) in the last year. The majority of participants had one ED visit (n=9), three participants had two ED visits, and one participant had four ED visits in the last year. One participant had 20 ED visits in the last year indicative of a high utilizer. The majority of participants were not hospitalized in the last year and participated in the RHWP. Table 16 summarizes the use of health services by the interview participants.

Table 16. Health behavior (use of health services) of interview participants (n=14)	
Variable	**Mean (SD), Range or n (%)**
Health Behavior (Use of Health Services) – Traditional Domain	
Visited PCP in last year	14 (100.0)
Number of PCP visits in last year	6.2 (6.5), 0-24
Hospitalized in last year	5 (35.7)
Number of times hospitalized in the last year	0.4 (0.6), 0-2
Visited the ED in the last year	14 (100.0)
Number of ED visits in last year	2.8 (5.0), 1-20
Participate in RHWP	9 (64.3)

Reasons for ED visit

The majority of participants (n=10) visited one of two community hospital EDs and four participants visited an academic medical center ED. The participants' reasons for ED use were categorized as fall, not feeling good, pain, infection, and medication-related, heart-related, or catheter-related. A participant may have had more than one reason categorized based upon their response to: "Please describe your reasons for using the ED." The categorized reasons for ED visit along with representative quotes from participants are summarized in Table 17.

Table 17. Categorization of participants' reasons for going to the ED and representative quotes	
Reason for ED visit[a]	**Representative quotes**
Pain	*Participant 3:* "I was having um intense urinary tract pain" *Participant 4:* "…and pain in my body. Going down my legs. So when I got off the bus up here, I just could not make it…I sent my own self to the emergency room…somebody call me an ambulance cause I was hurting…when you hurting you want to go somewhere" *Participant 5:* "It was itchy and painful" *Participant 7:* "Cause I had been having problems with my ankle I mean my feet and uh they got into they got so I couldn't walk on it…. I got ache I couldn't walk on it…It was swollen and painful" *Participant 11:* "I was riding my bicycle and I uh fell off my bicycle and hit my head and my chest and uh I waited bout a week but my chest pain kept getting worse…So I decided to go because I was afraid I smashed something in my chest….It seemed like it was getting worse and then like I said the length of time."

Not feeling good	*Participant 4:* "I told you I took sick. My foot doctor…waiting for the bus…uh got sick" *Participant 9:* "Um, I was just sitting talking and I got sick…They said I uh, they said I passed. I fainted...I started upchucking…Um, they bless her heart. They poured water and everything on me. And they said this guy had to hold me up because the way I was going I couldn't breathe." *Participant 10:* " 'Cause I wasn't feeling good really…But they didn't, they thought I might have. They said I had seizures. But I know I don't. But they saying I might. I may have to fall out. So they sent me on…I just was out of it." *Participant 12:* "I was feeling just really weak and lightheaded."
Infection	*Participant 5:* "I had a spider bite…which had developed some infection…so it was swollen so that's why I went to the emergency…red and swollen…on my arm" *Participant 13: "*Actually I didn't call anybody but uh uh I sudden they came two policemen and the ambulance car. And they said that you have to come with us to the emergency room. How uh eh they said that they would tell you…when I get there eh the hospital told us that you got pneumonia…Yeah that's why"
Fall	*Participant 1:* "I had fell and bust my head open and my legs- I couldn't walk. I couldn't get off the bed…yeah it both legs. I couldn't hardly move. It what made me fall, they gave away." *Participant 11:* "I was riding my bicycle and I uh fell off my bicycle and hit my head and my chest."
Medication-related	*Participant 6:* "They made me go, uh the wellness clinic was here and I came down and I had swollen face, lips, uh teeth, everything. And they made, they went got [apartment building employees] the manager and they made me go. They even paid my cab fare" *Participant 12:* "I hadn't been taking my medications correctly…Um that was a big part of it…for some reason I had just stopped taking them. I understand people do that every now and then. I don't know why. But we do, just every now and then just stop taking them"
Heart-related	*Participant 8:* "Yes my, I couldn't catch my breath…and I had went over two weeks and didn't tell nobody…couldn't catch my breath. Having a heart attack. Whew" *Participant 14:* "My blood pressure was high."
Catheter-related	*Participant 2:* "Because the suprapubic tube… I was unaware of it was working, not working or disconnected."

[a] Participant may have had more than one reason for going to the ED

Ambulance Use

The majority of participants arrived to the ED via ambulance. Table 18 describes the participant's control of the decision-making process for calling the ambulance and representative quotes. Other methods of transportation were cab, bus, and driving him or herself. Participant 6 (medication-related swelling) took a cab to the ED at the recommendation of the apartment building's employees and RHWP clinic providers. Participant 5 (infection-spider bite) drove to the ED but did not go alone. Participant 11 (chest pain after bicycle fall) caught the bus to the ED.

Table 18. Participants' control of decision to use the ambulance for transportation to the ED and representative quotes

Participant's decision-making process[a]	Representative quotes
Autonomous-decided to call ambulance	*Participant 1:* "Well, the first time I fell, my door was unlocked. So a friend of mine that live in the building, came by and as they come in and I was on the couch…and I couldn't get up. And um I had bust my head open. And I had made it to crawl to the couch. And she called, she went downstairs and got the security guard…The security came up there and then called the ambulance…So the ambulance came and the police came with them. I wouldn't go at first and so I fell down again later on though that morning…Yeah the same day… and I called down to tell them um to tell the ambulance to come back" *Participant 4:* "The ambulance came and got me. I told somebody to call the ambulance...I was hurtin' " *Participant 7:* "It was so bad I couldn't walk on it, I had to call the ambulance." *Participant 12:* "I called them…Well it just got to where like I said, I could…But then it gotten to be I knew I was in trouble and I needed to call"

Relinquished decision-making control	*Participant 9:* "Um, they bless her heart. They poured water and everything on me. And they said this guy had to hold me up because the way I was going I couldn't breathe…But I do remember her saying I got to call the ambulance. I just gotta." *Participant 10:* "Yeah I thinks somebody called it for me but I'm not sure about that either. Now I know I don't know if the police…I don't know if the emergency squad people just came and took me. Or if somebody called me. Or somebody called and just came and took me. I'm not sure" *Participant 13:* "They, they called the ambulance. The hospital cause they, they check uh the Coumadin and the blood, every week, so I was…Last result was so they discovered that I have some bacteria" *Participant 14:* "Uh my physical therapist? (And your physical therapist was here with you at the time?) Right."

[a] Participants 2, 3, and 8 did not answer how ambulance was contacted

Tests performed in the ED

Several of the participants reported having tests done in the ED. Table 19 describes participants' tests or exams performed in the ED and representative quotes. The most common tests were x-rays or CAT scans and laboratory tests.

Table 19. Participants' tests in the ED and representative quotes	
Tests performed during ED visit[a]	**Representative quotes**
Imaging	*Participant 1:* "the only thing I know they did they x-rayed, put me through the CAT scan…what they did, they um, when I had to go to the x-ray…They rolled my whole bed down there. Then I rolled over on the iron thing…They had to roll me over." *Participant 3:* "They did … and a CT scan." *Participant 4:* "um forgotten them but I know they took x-rays in there" *Participant 5:* "Um let's see. They done an x-ray on the arm…and um that's the only tests that they performed." *Participant 7:* "They uh, they took x-rays" *Participant 9:* "I had um all kinds of stomach x-rays. And what else did they do? And when they put the sonogram thing on my stomach they said they found something but they wasn't for sure… so then, I had to go back and take, drink something and they took pictures…and they said that um it was my colon…and they talked to my son and they advised me to have an operation. Um they said it was serious, but it had to be done." *Participant 10:* "When I went back they x-rayed everything." *Participant 11:* "Only thing I know they took x-rays." *Participant 12:* "Yes, did x-rays. Um I don't remember what (laughs) but they did I remember that. Probably my chest. " *Participant 13:* "They take …and x-rays." *Participant 14:* "… and CT scan. [CT scan, did they do any chest x-rays?] Yes."

Laboratory tests	*Participant 3:* "They did blood culture and a urine analysis …" *Participant 5:* "They gave me um the IV fluid…to inject I guess I think they did do some blood, they did do blood work…Yes they did do that" *Participant 10:* "And they did um took a whole lot of blood to see what was going on. I thought I would bleed out (laughs)" *Participant 12:* "And I think my blood but they may have done other things and I just wasn't aware of it, I'm not sure" *Participant 13:* "They take blood and…." *Participant 14:* "Lab work"
Blood pressure	*Participant 6:* "… blood pressure, oxygen, and then they gave me um IV with um corti-there um steroid" *Participant 12:* "Uh my blood pressure." *Participant 14:* "They just did the blood pressure."
Electroencephalogram(EEG)/ Electrocardiogram (EKG)	*Participant 6:* "They um electrocardiogram…" *Participant 10:* "I know they did with my head… [So when you they said they did your head did they put those wires on your head?] Mmhmm (yes)"
Stitches/staples	*Participant 1:* "Um. The first thing they did was stitch me and put some um staples in my head."
Observation	*Participant 2:* "No, the it, was uh, what you call out? In other words, when he pulled the bandage away from the incision… he saw the tube was disconnected"

[a] Participants may have reported more than one test in the ED.

History of problem associated with the ED visit

The length of time for participants having the problem associated with their ED visit ranged from the same day to a week to years for chronic issues. Some participants were unclear on the history of the problem associated with their ED visit. Themes that emerged from the length of time related to their problem and associated ED visit are presented in Table 20 along with representative quotes, the categorization of the reason for their ED visit, and method of arrival to the ED. Participant 1, 2, 3, 6, 8, 9, and 14 had a history of going to the ED for the same problem. Although time of ED visit was not obtained in all interviews, three participants used the ED during the night or weekend. Themes that emerged with regards to communication with a health care provider prior to going to the ED were: no communication with a health care provider, communication 1-2 days before, communication on the same day, and unknown timeframe of communication. Most participants did not communicate with a health care provider before going to the ED, however, two participants were referred to the ED from a health care provider. Themes that emerged from whether the participant had a recent change to their medications prior to visiting the ED were: no changes, participant stopped medication, participant added a medication, and a health care provider changed their medication.

Table 20. Length of time related to ED visit problem, representative quotes, reason for ED visit, and method of arrival to ED			
Length of time	**Representative quotes**	**Reason for ED visit**	**Method of arrival to ED**
Same day	*Participant 1:* "So the ambulance came and the police came with them. I wouldn't go…At first and so I fell down again later on through that morning…Yeah the same day. And I had to and I called down to tell them um to tell the ambulance to come back."	Fall	Ambulance
	Participant 2: "The tube approximately came out Thursday night …around 8 o'clock that evening. He didn't discover it until 4:30 AM when I went…"	Catheter-related	Ambulance
	Participant 3: "Um, about 24 hours"	Pain	Ambulance
	Participant 4: "I didn't have. I got it got it that day."	Pain / Not feeling good	Ambulance
	Participant 6: "Two and a half hours"	Medication-related	Cab
	Participant 9: "Mmm no I had felt bad. I had been to the store, bought me some flowers, came back. I wanted some string beans and the put the stuff away. And just a normal day. This was real sudden."	Not feeling good	Ambulance
	Participant 14: "I was you know have high blood pressure." [Note: researcher was present when ambulance was called for symptoms from that day]	Heart-related	Ambulance

1-2 weeks	*Participant 7:* "About uh a week and a half. It was started, then it started hurting worser and worser until I couldn't walk on it. The Friday I said I couldn't take it no more. Had to go to hospital."	Pain	Ambulance
	Participant 8: "Well it wasn't over 2 weeks, it appeared like certain times of the evening. I might be sitting upstairs looking at the TV and stuff and all of a sudden I can't hardly breathe but this lasted maybe 20-30 minutes at the most. And it would go away but it would come back say maybe later that night or whatever but it scared me enough to call the ambulance and get down to the hospital."	Heart-related	Ambulance
	Participant 11: "I was riding my bicycle and I uh fell off my bicycle and hit my head and my chest and uh I waited 'bout a week but my chest pain kept getting worse."	Pain/ Fall	Bus
	Participant 12: "Probably a couple of weeks."	Not feeling good/ Medication-related	Ambulance

Unclear	*Participant 10:* "I guess it was it was that span that I was trying to get stuff together…So but I got sick and the lady in the…emergency room she didn't do anything but take my temperature and make sure I was like, you know there and I wasn't not there. She just so. That was what she did…and um that's it.[Ok. Um just so I'm clear, you fell in your apartment…But you didn't go to see a doctor…And then you did go to the emergency room when you weren't feeling quite right…And then you came back and then you went again to the emergency room?] Now that's what I am thinking…Cause I know I didn't, they did it a second time. I didn't do it. [And who is they?] Now I know I don't know if the police, I don't know if the emergency squad people just came and took me. Or if somebody called me. Or somebody called and just came and took me. I'm not sure…I'm not sure."	Not feeling good	Ambulance
	Participant 13: "I uh didn't feel anything. [Did they mention how long they you might have had it? Or they caught it right away?] Uh they didn't."	Infection	Ambulance
A few days	*Participant 5:* "Let's see. This was Sunday and this happened, this happened Friday…Friday night I'd say. [Did it get worse or was it bad from the beginning?] It got worse as the days progressed…"	Pain/ Infection	Drove self

View of ED experience

Most of the participants felt that the ED visit helped their problem. Problem resolution emerged as a main theme. Perceptions of staff incompetency or lack of addressing participant's concerns emerged in participant's ED visits with unresolved problems. Representative quotes of the participant's view of their experience in the ED are provided in Table 21.

Table 21. Participants' view of their ED experience and representative quotes	
How ED visit helped problem	**Representative quotes**
Problem resolved or addressed	*Participant 1:* "Yeah it helped a whole lot 'cause I mean they gave me vitamins and stuff like that. Made sure I eat." *Participant 3:* "They were able to diagnose with a UTI...and give me antibiotics" *Participant 4:* "Cause they x-rays and do what they want. See what the cause of feeling that way." *Participant 5:* "Oh they helped me a whole lot because with the antibiotics and that infection that I had and the swelling and the pain that I had" *Participant 6:* "Well they knew exactly what I had taken… time I walk in" *Participant 7:* "Help me to walk like I'm walking now." *Participant 8:* "They helped me. God knows I don't know how, but they helped me. Cause I'm still I'm talking to you now" *Participant 9:* "100% it helped. Because you may not um I had been having a bowel problem, wearing pampers for over five years. I had the colony, but they said they couldn't find nothing. But I was still wearing Pampers. [Right until when you just got so sick and they found it?] Mmhmm (agreement)." *Participant 10:* "Well the one thing helps … by getting somebody else …that they come in sick. And know how treat the person and they know how to, you know eliminate some stuff that they would do. Otherwise then you put the patient up there for no reason at all." *Participant 11:* "It stopped my pain. Well I mean I'm still having the pain but it's not you know. It's not you know, how I want to say it, it's not consistent as you know…As it was. It's periodically now I go through pain." *Participant 12:* "Well, they were very efficient and I don't know what else to say. " *Participant 13:* "Uh actually they were uh friendly and they did everything required …was perfect."

Problem not resolved	*Participant 2:* "And the ER doctor couldn't uh couldn't reopen it…to put it back in…" *Participant 14:* "It didn't help my problem…"
Perception of staff incompetency	*Participant 2:* "and for some unknown reason the emergency doctor and his three nurses…couldn't put a damn foley in…And they panicked…They called the yellow cab and sent me, without my okay…but I gave them the okay…they sent me to the [Urologist's office]"
Perception of staff not addressing concerns	*Participant 14:* "I went in the ER and they um well first, I was a nervous with the stroke. When I went in, the lady kept uh, I said you know my blood pressure is high, I'm getting nervous…She said "I know, don't worry about it" well, she wasn't a nurse, she was admission person…And I was in the hospital and when somebody tells me they don't feel good and their blood pressure is high I get nervous…She didn't. [She didn't do anything?] Nope."

Overall Themes Related to ED Use

The overall themes related to ED use in these participants are listed in Table 22. Participants mainly used the ambulance for transport to the ED. The timeline for ED use fell into two categories: 1) Timely use of ED (e.g. visiting the ED the same day as problem) or 2) Wait-and-see /self-care until deciding problem was urgent (e.g. waiting a week until worsening chest pain prompts ED use). Lack of communication with a health care provider prior to deciding to use the ED emerged as a theme. Most participants felt that the ED visit helped their problem.

Table 22. Overall themes related to ED use
High use of ambulance services for transport to ED
Timely use of ED
Wait-and-see/self-care until deciding problem was urgent
Lack of communication with a health care provider prior to ED visit
Problem resolution

Transitions of Care based upon Coleman's Care Transition Intervention[83]

Themes identified from questions that addressed transition of care problems, guided by the four pillars of the Coleman Care Transition Intervention[83] are presented in the following section. The results are grouped by the four pillars: medication management, personal health record, follow-up care, and knowledge of warning signs and symptoms of a worsening condition and who to contact.

Medication Management

Most participants were prescribed a medication after their ED visit. Table 23 describes the participant's responses to the question "Were you prescribed any medication in the ED to take after your visit?" Pain medication and antibiotics were the most common medication classes prescribed. Three participants were not prescribed medications at discharge. Two participants knew that their medications were changed but did not know which ones. One participant could not remember if he/she was prescribed a discharge medication.

Table 23. Medications prescribed in the ED after visit and representative quotes	
Medication[a]	**Representative quotes**
Pain medication	*Participant 2:* "…and he gave me a narcotic medicine by the name of uh Nor- Norco. 7 and a half slash 325" *Participant 5:* "And they also gave me oxycodone-acetaminophen…5-325mg per tablet. take one tablet by mouth every 4 hours as needed for pain quantity 20" *Participant 7:* "[It looks like they gave you some acetaminophen and hydrocodone and indomethacin] They gave me two bottles of pills. I got them too" *Participant 11:* "Ibuprofen 600mg and Oxycontin. Percocets." *Participant 14:* "[They prescribed you a pain medication that you decided not to get?] Right. [And you said that it was because you were on the tramadol] (shakes head yes)"
Antibiotics	*Participant 2:* "Yeah they gave me Cipro or syepro(different pronunciation of Cipro) for antibiotic" *Participant 3:* "I think it was just the antibiotic." *Participant 5:* "They gave me cephalexin 500mg capsules. Take one for by mouth four times a day for seven days" *Participant 13:* "Yeah I, I got prescription for (antibiotics muffled)"
Steroids	*Participant 6:* "Yes. The steroids. That's why I feel stupid I think."
Medications changed, not sure which ones	*Participant 8:* "When I was… they had changed every one of my medications. [Ok. So all of your prescribed medications to take home with you they were different from the ones when you went in?] Yes ma'am [Do you know uh which?] The only one I think that they didn't change was the 81…and I had stopped taking that over a year. The 81, the aspirin" *Participant 9:* "The only thing they changed was my blood pressure medicine…They changed it all together. Instead of what I was taking I take two little pills a day. I forget all my…[Do you happen to know the name of it by any chance?] No"
No medications prescribed	*Participant 1:* "No. I don't know if there was. …No they didn't give me no refill. They mad cause I wouldn't stay there…they wanted me to sign a paper and that was it " *Participant 4:* "They didn't give me no medication. They got my business and gave me papers to go home." *Participant 10:* "Uh uh. (no)"
Don't remember	*Participant 12:* "I don't remember if I was. Um yeah they did give me stuff in the hospital but I don't remember what it was."

[a] Participant may have had more than one medication type prescribed.

All but one of the participants who were prescribed a discharge medication received their medication. A delay in receipt of medication after discharge emerged as a theme. Three out of the five participants who did not receive their medication the same day as discharge relied on a friend or family to get their medication indicating transportation was a concern. Most participants reporting using a local community pharmacy for filling their prescriptions. Table 24 summarizes receipt of medications after discharge, representative quotes, pharmacy location, and participant's assistance with obtaining their medication.

Table 24. Receipt of medications after discharge, representative quotes, location of medication fill, and if participant had assistance with obtaining medication			
Medication receipt after discharge	**Representative quotes**	**Location of medication fill**	**Help with obtaining medication**
Same day as discharge	*Participant 11:* "I went to the pharmacy. [And you, were you able to get them filled the same day?] Yes."	Community pharmacy	Self (bus)
	Participant 12: "They (ED) gave me some to take home with me. And then I got them filled when I went to the doctor. (PCP office has a pharmacy)"	ED, PCP office	Self
	Participant 13: "Yeah because I uh uh that is agreement for the uh …Pharmacy [Ok. You get them you get them delivered here?] Yeah"	Community pharmacy	Delivery service
Delayed receipt	*Participant 5:* "It was around It was around trying to …11:27PM I think I was discharged…Yes I did have to wait till the next day because um I went to (community pharmacy) and (it) was closed… the pharmacy. Cause this was almost near midnight by the time I got home"	Community pharmacy	Self
	Participant 6: "I have a guy that he takes me or he'll go pick it up for me…All depend on how I feel, he'll go pick it up for me. I rather that. [You got home Thursday, and you start…] I didn't get the medicine until Friday."	Community pharmacy	Friend
	Participant 7: "I couldn't get them that evening. So I had to go another day and get them and I had somebody take me…it was uh I went in there Friday I got my medicine that Sunday cause my cousin came up got me. came up to (hospital) and got it …because I didn't have a way to get it and I finally call him and he came and took me to um the pharmacy"	Hospital pharmacy	Cousin
	Participant 8: "Yes ma'am. Very. Was it the same day? No it was the very next day. … I go down to (community pharmacy), right here on (local area)."	Community pharmacy	Self
	Participant 9: "[did someone pick them up for you?]My son. One of my sons. …The next day because I didn't get home until like 9:30 at night"	Community pharmacy	Son

[a] Participants 2 and 3 indicated they received their medication but no other information was provided. Participants 1, 4, 10 were not prescribed a medication. Participant 14 decided to not fill his/her prescribed pain medication.

Table 25 summarizes participant's responses to the question: "Do you use a pillbox or other reminder system to manage your medications?" Lack of medication reminder system use by participants emerged as a theme. If used, a pillbox was the most common medication reminder system. One participant stated that they used their cell phone alarm as a reminder but could not explain how it was programmed.

Table 25. Medication reminder system used by participants and representative quotes

Medication reminder system used[a]	Representative quotes
None	*Participant 1:* "no uh uh I don't have nothing" *Participant 2:* "No I can't because I had an operation for carpal tunnel that didn't work out in my left hand…So I put the pills in a pillbox… I can't pick 'em out" *Participant 5:* "No I just take, go out of the bottle" *Participant 6:* "Uh uh. I don't need it, I know what to take what not to take and what time." *Participant 7:* "uh uh (shakes head no)" *Participant 8:* "No, I just take the medicine. Be there right on the table where I can see it…And don't forget it." *Participants 9, 11:* "No." *Participant 13:* "Uh I, I don't remember…Uh come in the small what are they, they what you call tube…Yeah, it's like this size, circular (hands make shape of regular size pill bottle)"
Pillbox	*Participant 3:* "Yeah, I use a pillbox". *Participant 4:* "Yeah I got a pillbox." *Participant 12:* "Um. It's just a um pillbox … for a week. … It had two sides to it for morning and evening." *Participant 14:* "[PM medications are in a pillbox.]"

Own system	*Participant 14:* "I make my own. [Participant has a basket near his/her couch with AM medications separated in to pill bottles. PM medications are in a pillbox.]"
Phone alarm	*Participant 10:* "My phone…And um um my phone's really all. Cause I use my phone to record see that? I use my phone. The doctors did it for me. See?…They have it set up. And then when I learn how to do it I set up more [could not figure out his/her phone reminder system] …You know I, Ok let me think, how did I do it? [Is it an alarm that goes off?] Yeah. Ok yeah I just took it off- it's an alarm (shows phone set up) …Now that I do not know by looking at it…[Well, how often do you have to take your medicine a day?] Um let me see, 1, 2, 3 times a day (still looking at phone). Well I have to learn how to do this every time (still couldn't figure out his/her phone)"

[a] Participant 14 used two medication reminder system types (own system and pillbox).

Lack of a current medication list emerged as a theme to the question: "Do you have a current medication list?" Only three participants carried a medication list, but two stated their list was not current. Three participants stated that they had a current medication list but did not carry it with them. Another three participants considered their discharge paperwork to be their current medication list. Themes that emerged from questioning participants about a current medication list and representative quotes are provided in Table 26.

Table 26. Participants' current medication list and representative quotes

Current medication list	**Representative quotes**
None	*Participant 1:* "uh uh (no)" *Participant 4:* "I ain't got no list." *Participant 8:* "No more than going by the bottle that I'm taking" *Participant 10:* "Mm no. cause what I carry with me is the phone and that lets me know hey you missed a medicine…And that way I know when I get back that it might alarm again. But it's only reminding me" *Participant 11:* "No."

Medication list, but does not carry with them	*Participant 2:* "I have a list upstairs but I got it in my mind…In other words I can give you every last one of them." *Participant 3:* "I do. I don't have it on me. [Did you bring that with you to the emergency department?] No, they have all the medications listed in their computers." *Participant 13:* "No I uh take the medication. [Do you have a list of them?] Oh. My room but I can (seem confused here)"
Discharge paperwork only	*Participant 5:* "No this is my list.[This is your list?] Yes (discharge papers)" *Participant 6:* "uh. All on that list right there. (discharge papers)" *Participant 9:* "Yes. (discharge papers) [Do you have anything else that you carry with you, like a wallet card?] Nah uh uh."
Carries medication list with them	*Participant 7:* "I mean I got one but I think it need changing. I don't think it's right now. This what I usually keep with me (hands medication book) Phone numbers I got to change too. Got to change my primary care doctor's phone number on here. But here goes, let's see yeah but I got to update mine with these pills though" *Participant* 12: "Yes. [Ok. And do you carry it with you when you go to the doctor?]Yes. Who gave you the medication list?] Um (PCP) [Do you remember if it is a full sheet or a wallet card?] It's a full sheet." *Participant 14:* "Yes (goes into purse)… I need to update it but it's got most of them. It has all the medication I take. There's some on here I don't take anymore. (pulls out typed list from wallet on piece of white paper)"

Personal Health Record

None of the participants reported having a personal health record as described in the interview script. Participant 2 reported having "a clinical summary upstairs from …my pain management doctor…then the other one is from my PCP my primary care." Two participants expressed interest in having a personal health record. For example, participant 12 felt that a personal health record was "a good idea. I should have something like that." Participants were asked what information they had to provide to their primary care doctor or other health care provider about

their recent ED visit. Table 27 provides a summary of responses to this question and representative quotes. Discharge paperwork emerged as participant's main information source about their ED visit. None of the participants reported being given a copy of their ED visit care plan. Participants 3, 7, and 12 indicated that they were given a discharge summary when asked about receiving a care plan from their stay. Participant 10 responded that "I think my case manager got that" when asked about receipt of a care plan, but was not sure.

Table 27. Participants' responses to what information do you have to provide to your primary care doctor or other healthcare provider about your recent ED visit and representative quotes

Description of information	Representative quotes
Discharge paperwork	*Participant 2:* "That's the… Ok, the paper that they gave me from the discharge from… they didn't want me to have it" *Participant 3:* "Just a discharge summary and my prescriptions and that was it." *Participant 4:* "They gave papers said I can go home. I discharged I can go home. However I threw out" *Participant 5:* "Yes um yes and after care or something… [discharge orders.]" *Participant 6:* "That's it right there (discharge papers)" *Participant 7:* "About when I went to the hospital? That's all I have right here. [the discharge instructions?] Yeah." *Participant 11:* "Just this form right here. (discharge papers)" *Participant 12:* "Why I went, how long I stayed um what they gave me um I don't remember anything else. [Um did they give you paperwork to give to your doctor?] I think so. [Was that in the discharge summary paperwork?] Yes." *Participant 13:* "Yeah they gave me eh they gave me eh two three pages. [Ok. Was it discharge paperwork? Did it say discharge or anything on there?] No." *Participant 14:* "[Did they give you any paperwork? Just the discharge?] Yeah"

ED communicated with PCP	*Participant 6:* "He probably already have it. [Did you know if they fax over?] They probably did. Cause uh the lady called me from his office Friday and Saturday to check on me."
None	*Participant 9:* "Uh no no"
Not sure	*Participant 10:* "Well I don't know. All that I know is that I went….Now that's what I'm wondering about now, is that the paperwork that I supposed to be showing but I saying with um with trying to keep everything together even in paperwork… is kind of rough because you don't get all the paperwork you know"

Follow-up

Table 28 provides a summary of answers to the question "What health care providers are you supposed to see for follow-up" and representative quotes. Participants were instructed to follow-up with their PCP most often. One participant was not told to follow-up with their PCP but it was noted in their discharge paperwork. One participant had home health nursing arranged for after discharge and two participants were instructed to see a specialist. Five participants reported not being told to follow-up with a health care provider after discharge.

Table 28. Instruction for follow-up care, type of follow-up health care providers, and representative quotes	
Health care provider type	**Representative quotes**
PCP	*Participant 5:* "Well they did say you should follow up with your doctor…But I didn't have any need to do that. [And with the doctor was that with your PCP?] Yes" *Participant 7:* "This doctor on here (participant's PCP)." *Participant 8:* "Let's see I come out on the…or something like that. Anyway I went and see him (PCP) the next day" *Participant 9:* "I had so many doctors. I can't uh boy. Hmm but I have I know I have to go to um Dr. …[What kind of doctor is he?] Well all all general practitioner." *Participant 10:* "My primary what you call my primary care." *Participant 11:* "Well I um I go to… and my primary care doctor there." *Participant 12:* "(name of PCP office)."
Specialist	*Participant 2:* " Dr…(participant's urologist)" *Participant 8:* "Oh yes. Yes. I got had to see a heart doctor."
Home health nursing	*Participant 13:* "Yeah they, they said they will send you nurses, uh for to check for checking and follow up"
None, but scheduled a PCP appointment	*Participant 1:* "Uh uh. They didn't. [Have you seen your PCP since you came out of the hospital?] Yeah" *Participant 6:* "No but I had a appointment to go to him anyway cause of the Coumadin. I have to go once a month"
None, but noted in discharge paperwork	*Participant 14:* "Is it in there? (discharge papers) [Let's see, they say to follow up with this doctor. Is that your primary care doctor?] Yeah. [Ok but they didn't actually tell you to do that am I correct?] Yeah. [I don't have any kind of note that you should see your primary care doctor in the next week or anything like that, they just have the person's name. When do you go see your primary care doctor again?] When I need to."
None	*Participant 3:* "Um. surprisingly they didn't say anything about a follow-up" *Participant 4:* "They did not tell me that and send me home." *Participant 14:* "No"

Most participants had scheduled and/or completed follow-up care with a health care provider after their discharge. Five participants scheduled an appointment and saw a health care provider for follow-up at the time of their interview. Another five participants had either an appointment scheduled or planned to walk at the RHWP clinic for follow-up. Themes related to the question "Have you made the appointment (follow-up)?" along with representative quotes are summarized in Table 29.

Table 29. Participants' follow-up care and representative quotes

Follow-up care	Representative quotes
Appointment scheduled and completed	*Participant 1:* "Yeah he (PCP) the one that took the staples out of my head." *Participant 2:* "I saw him (PCP) on the …" *Participant 8:* "Anyway I went and see him (PCP) the next day" *Participant 10:* "[Primary care doctor, yeah. And you said you went to go see them already?] Mmhmm. (Yes)" *Participant 12:* "[Do you remember when you went to the (PCP)? After getting out of the hospital?] Um it would have been like Monday or Tuesday of the next week"
Appointment scheduled	*Participant 6:* "I had a appointment to go to him anyway cause of the Coumadin. I have to go once a month" *Participant 7:* "uh I had appointments for him Monday but I couldn't go Monday so I got to call to make another appointment before I go…So I got to call them 'cause I had to go out of town." *Participant 9:* "The only one I made an appointment with is my primary doctor." *Participant 11:* "Yes. Well, I'm automatically scheduled to see them uh next Wed, not next Tuesday. [And you already had that appointment before you went into the emergency department?] mmhmm (agreement)"
Plans for walk in at RHWP clinic	*Participant 13:* "Actually, I don't… a certain appointment…That why they uh their visits on Thursday so. [Is (RHWP) your primary care doctor?] Yeah."
No appointment scheduled	*Participant 14:* "[You don't have a scheduled appointment?] No"

Knowledge of warning signs and symptoms of a worsening condition and who to contact

Most participants knew warning signs and symptoms of a worsening condition. Medication-related education and education about potential complications was also reported. Six participants did not know what to look for ("red flags") as a sign or symptom of a worsening condition. Themes related to knowledge or education received based on responses to "What are the warning signs and symptoms that your condition is getting worse?" and representative quotes are reported in Table 30.

Table 30. Knowledge of warning signs and symptoms of a worsening condition and representative quotes/responses

Knowledge/ Education received	Representative quotes/responses
None	*Participants 7, 10, 12, 14:* "No." *Participant 4*: "No. I think I'm doing fine. Cause if I won't doing fine, I would notice it. I notice if I'm doing fine. I know if I'm not doing fine. I would know. I know I'm doing good"
Warning signs and symptoms	*Participant 2:* "When the bag don't fill up…It fills up overnight ...and during the course of the day" *Participant 3:* "Um, fever, um vomiting, my lower back starts to hurt…um things like that" *Participant 5:* "Yes, they told to um at the entrance at the wound look at if you see a long black line or something coming up to your arm" *Participant 6:* "If I had the swelling again which I hope I don't" *Participant 8:* "my stool. And watching for you know how the stool is whether there blood." *Participant 9:* " I start getting dizzy and if I have a temperature"

Medications	*Participant 11: "*Only about the medications you know. If I you know get dizzy or you know and try not to drink alcohol with it or if I start vomiting with it. Mainly about the medication that they were saying that the medication did not work go..."
Potential complications	*Participant 13:* "Uh eh the practitioner told me that uh this the bacteria of the, caused by pneumonia and there is a possibility that this bacteria goes to all blood so if we are not make it quickly there is a fear uh or risk that your uh all your blood be contaminated"

Table 31 summarizes participants' responses to the question "What are you supposed to do if you notice your condition is getting worse?" and representative quotes. Most participants would return to the ED or hospital or call their doctor/hospital.

Table 31. What a participant would do if their condition worsened and representative quotes

What participant would do[a]	**Representative quotes**
Return to the ED or hospital	*Participant 11:* "…go immediately to (hospital) or call 911." *Participant 3:* "Um if it gets that bad I usually end back to there (ED)" *Participant 4:* "You go you go to the hospital. Call the ambulance… you get worse and you out in the street and you get somebody to call you the ambulance…I know I get somebody to call me the ambulance I get sick." *Participant 5:* "Come go, come back to the emergency room immediately." *Participant 6:* "Come back to the hospital." *Participant 9:* "Don't hesitate to come right back…to the emergency room"
Call doctor	*Participant 2:* "Call their number (specialist's office)… if they can't tell me nothing over the phone they will advise me to go to uh the emergency department" *Participant 10:* "No but I know to call the doctor because I don't go to the emergency room, like talking about it." *Participant 14:* "Well if I feel bad I would my (primary care doctor) and see what she would recommend" *Participant 7:* "To go to my primary care and call the numbers on here (PCP number)"
Call hospital	*Participant 12:* "Call the hospital again."
No idea	*Participant 13:* "Uh actually I uh I uh have no idea."
Sit down	*Participant 10:* "Sit my butt down."

[a] Participant may have reported more than one thing to do if they noticed a worsening condition

Overall Themes Related to Transitions of Care based upon Coleman's Care Transition Intervention[83]

The overall themes related to transitions of care in these participants are listed in Table 32. The themes are grouped by the four pillars of Coleman's Care Transition Intervention[83] medication management, personal health record, follow-up care, and knowledge of warning signs and symptoms of a worsening condition and who to contact. Themes that emerged from questions about medication management were: delay in medication receipt after discharge, lack of a current medication list, lack of education on use of a current medication list (e.g. carry in wallet and show ED care providers), and low use of medication reminder systems. None of the participants had a personal health record. Themes related to follow-up care were: discharge paperwork as an information source for health care providers, either instructed to see PCP for follow-up care or not being instructed about follow-up care, and adherence to follow-up care instructions. Themes related to warning signs and symptoms of a worsening condition included: educated on warning signs or symptoms, medications, or potential complications. Participants would either return to the ED/hospital or call their doctor/hospital if their condition worsened.

Table 32. Overall themes related to transitions of care based upon Coleman's Care Transition Intervention[83]
Medication management
Delay in medication receipt after discharge Lack of a current medication list Lack of education on use of a current medication list Low use of medication reminder systems
Personal health record
Lack of a personal health record
Follow-up care
Discharge paperwork main information source for other health care providers Instructed to see PCP for follow-up or Lack of instruction for follow-up care Adherent with follow-up care instructions (most scheduled and/or completed)
Knowledge of warning signs and symptoms of a worsening condition and who to contact
Educated on warning signs and symptoms, medications, potential complications Return to ED or hospital or Call doctor/hospital if condition worsens

3.2 Aim 1C

Descriptive results of the information collected from RHWP participant charts are summarized in this section. The results are presented by predisposing, enabling, and need factors collected from the participant's baseline intake form and participant visit information from the CCT. A total of 97 RHWP participants met the inclusion criteria of having at least one RHWP visit in 2014 with a completed CCT. The time period of visits with a completed CCT ranged from the start of CCT use in February - July and September - December 2014. There were a total of 526 RHWP visits with a completed CCT. No visits occurred in August of 2014 due to the renovation of the RHWP clinic space.

The mean age was 71.5 years (SD 9.3), range 45-94 and 80% of participants were 65 years or older. The majority were female (58%) and African American (61%). Over one-third of RHWP participants had less than a high school level of education. The predisposing factors of RHWP participants are summarized in Table 33.

Table 33. Predisposing factors of 2014 RHWP participants (n=97)	
Variable	**Mean (SD), Range**
Predisposing – Traditional Domain	
Age (n=95)	71.5 (9.3), 45-94
Age by category (n=95)	**n (%)**
< 65 years	19 (20.0)
65 - 69 years	21 (22.1)
70 - 74 years	20 (21.1)
75 - 79 years	16 (16.8)
≥ 80 years	19 (20.0)
Gender (n=97)	
Female	56 (57.7)
Male	41 (42.3)

Race/Ethnicity (n=69)	
African-American	42 (60.9)
Caucasian	26 (37.7)
Other	1 (1.5)
Highest level of education completed (n=68)	
< 12 years	24 (35.3)
High school (12 years)	22 (32.4)
Trade school	1 (1.5)
Some college	13 (19.1)
College degree	7 (10.3)
Master's degree	1 (1.5)
GED (n=32)	17 (53.1)

Enabling factors of 2014 RHWP participants are summarized in Table 34. The majority of participants had a PCP (87%) at baseline. Most participants had either Medicare or Medicare-Medicaid insurance. Over one-third of participants lived in the apartment building for 1-5 years and almost 40% lived there longer than 5 years. Only 21% of participants indicated that they had someone to help with their care in the home. Although 58 out of the 97 participants had a response to "anyone to help with their care?", 72 participants indicated a social contact to help with care. The most common type of social contact to help with their care was their child (e.g. son, daughter). Participants may have had more than one type of social contact to help with their care (e.g. friend and child). Half of the participants used an assistive device with over one-third reporting use of a cane. The majority of participants were not able to drive. Bus or walking were the most common reported other methods of transportation. In the 34 participants with a completed Activities of Daily Living (ADL) scale, the majority (79%) were considered independent (score of 6). Although a majority (82%) were considered independent in the ADL continence, it was the lowest in comparison to the other five ADLs.

Table 34. Enabling factors of 2014 RHWP participants (n=97)	
Variable	**n (%)**
Enabling – Traditional Domain	
Regular PCP (n=97)	84 (86.6)
Health insurance (n=90)	
Medicare	42 (46.7)
Dual-eligible Medicare-Medicaid	37 (41.1)
Medicaid	5 (5.6)
Veterans Administration	3 (3.3)
Virginia Coordinated Care	3 (3.3)
Years of residence (n=82)	
Less than 1 year	18 (22.0)
1 - 5 years	31 (37.8)
6 - 10 years	18 (22.0)
11 - 15 years	4 (4.9)
16 - 20 years	3 (3.7)
21 - 25 years	4 (4.9)
More than 25 years	3 (3.7)
Unknown	1 (1.2)
Anyone to help with care (n=58)	12 (20.7)
Relationship to contact to help with care (more than one response possible, n=72)	**n (%)[a]**
Child	34 (47.2)
Sibling	17 (23.6)
Friend	12 (16.6)
Other family member	10 (13.8)
Other[b]	7 (9.7)
Enabling- Vulnerable Domain	
Use of assistive devices (n=77)	39 (50.7)
Cane (n=65)	22 (33.9)
Walker (n=69)	21 (30.4)
Wheelchair (n=61)	5 (8.2)
Able to Drive (n=82)	19 (23.2)
Other methods of transportation (more than one response possible, n=56)	**n (%)[c]**
Bus	30 (53.5)
Walking	12 (21.4)
Family member	11 (19.6)
Friend	8 (14.2)
Other[d]	8 (14.2)
Van	6 (10.7)
Care Van	6 (10.7)

Activities of Daily Living Score (n=34)	n (%)
2	1 (2.9)
3	2 (5.9)
4	1 (2.9)
5	3 (8.8)
6 (Independent)	27 (79.4)
Activity of Daily Living (n=34)	**Independent: n (%)**
Bathing	30 (88.2)
Dressing	33 (97.1)
Toileting	32 (94.1)
Transferring	32 (94.1)
Continence	28 (82.4)
Feeding	34 (100.0)

[a] Response may have included more than one social contact relationship category, % of n=72
[b] Other family member includes: aunt, niece, nephew, granddaughter, and cousins. Other includes: aide, pastor, father, niece ex-husband, nurse's aide, care manager, church member, and girlfriend. Participant may have had more than one social contact type.
[c] Response may have included more than one transportation type. % of n = 56
[d] Other transportation included: taxi (2), Logistic Care transportation services (2), other charity (1), social worker arranged (1), nursing aide (1), apartment building's van (1)

Need factors of 2014 RHWP participants are summarized in Table 35. Descriptive statistics for the number of chronic conditions and mental health conditions are reported in Table 36. The mean number of chronic conditions was 6.1 per participant (SD 4.3) with a range of 0-17 chronic conditions. Almost half of the participants had 1-6 chronic conditions (1-3 chronic conditions: 22.7%; 4-6 chronic conditions: 26.8%). The majority of participants indicated a medical history of hypertension (85%), visual impairment (74%), arthritis (68%), and high cholesterol (56%). About one-third of participants reported a mental health condition history (depression, bipolar disorder, schizophrenia). Depression was the most common mental health condition reported.

Only one participant reported a history of illicit drug use and 20 participants reported using alcohol. In those that reported their amount of alcohol use per week (n=15), the majority were classified as occasional or seldom drinkers (67%). Only three participants' alcohol use fell above

the National Institute on Alcohol Abuse and Alcoholism's recommended alcohol intake guidelines for older adults of no more than 7 alcoholic drinks per week or 3 alcoholic drinks per day.[109]

Table 35. Need factors of 2014 RHWP participants (n=97)	
Variable	**n (%)**
Need – Traditional Domain	
Medical history	
High blood pressure / hypertension (n=75)	64 (85.3)
Visual impairment (n=68)	50 (73.5)
Arthritis (n=69)	47 (68.1)
High cholesterol (n=66)	37 (56.1)
Diabetes / high blood sugar (n=72)	33 (45.8)
Insomnia (n=65)	31 (47.7)
GERD (n=67)	31 (46.3)
Ankle/leg swelling (n=65)	30 (46.2)
Sciatica or chronic back pain (n=66)	30 (45.5)
Constipation (n=66)	28 (42.4)
Depression (n=65)	28 (43.1)
Loss of feeling/numbness/burning in legs or feet (n=68)	28 (41.2)
Hearing impairment (n-69)	24 (34.8)
Urinary incontinence (n=69)	23 (33.3)
CAD / heart disease (n=63)	20 (31.8)
Headaches / migraines (n=67)	20 (29.9)
Cancer (n=65)	18 (27.7)
Weight loss > 10 lb. in last year (intentional) (n=63)	17 (27.0)
Alzheimer's disease / memory problems (n=65)	15 (23.1)
Asthma (n=67)	14 (20.9)
COPD (n=64)	14 (21.9)
Stroke (n=64)	14 (21.9)
Kidney impairment (n=66)	14 (21.2)
Diarrhea (n=66)	13 (19.7)
MI / heart attack (n=61)	12 (19.7)
Osteoporosis (n=61)	12 (19.7)
Thyroid problems (n=60)	10 (16.7)
Bipolar disorder (n=60)	8 (13.3)
Schizophrenia (n=59)	7 (11.9)
Seizures (n=64)	6 (9.4)
Inflammatory bowel syndrome (n=56)	4 (7.1)
Parkinson's disease (n=62)	1 (1.6)

Need – Vulnerable Domain	
Mental health condition history	
Depression (n=65)	28 (43.1)
Bipolar disorder (n=60)	8 (13.3)
Schizophrenia (n=59)	7 (11.9)
Alcohol or illicit drug use	
Illicit drug use (n=75)[a]	1 (1.3)
Alcohol use (n=83)	20 (24.1)
Amount of alcohol per week (n=15)	
Occasional or seldom	10 (66.7)
Above recommendation for older adults[b]	3 (20.0)
Weekly use but below recommendation for older adults	2 (13.3)

[a] Illicit drug use was marijuana

[b] Recommendation by National Institute on Alcohol Abuse and Alcoholism- Adults over age 65 should have no more than 7 drinks/week or 3 drinks/day[109]

Table 36. Number of chronic and mental health conditions in 2014 RHWP participants (n=97)

Number of chronic conditions[a]	**n (%)**
0	10 (10.3)
1-3	22 (22.7)
4-6	26 (26.8)
7-10	21 (21.7)
11-14	15 (14.5)
15 or more	3 (3.1)
Number of mental health conditions[b]	**n (%)**
0	66 (68.0)
1	21 (21.7)
2	8 (8.3)
3	2 (2.1)
	Mean (SD), Range
Number of chronic conditions	6.1 (4.3), 0-17
Number of mental health conditions	0.4 (0.7), 0-3

[a] Conditions not included from medical history (symptoms) were: ankle/leg swelling; loss of feeling/numbness/burning in legs or feet; constipation; diarrhea; weight loss > 10 lb. in last year

[b] Mental health conditions included from medical history: depression, bipolar disorder, and schizophrenia.

Information about the use of health services (hospitalizations, ED visits, PCP visits) from the baseline intake form is summarized in Table 37. Number of RHWP visits was obtained from completed CCT forms. The mean number of RHWP visits per participant was 11.5 (SD 8.7) with a range of 1-35 visits. The years reported for last PCP visit ranged from 2012-2014.

Forty-three participants reported the year of their last hospital admission. Over one-third had a hospital admission in 2011 or earlier. The most common hospital used was one of the HCA Hospitals. The number of times admitted to the hospital in the last six months ranged from 0-5 times. Most participants indicated that they did not have a hospitalization in the six months prior to participating in RHWP (67%). The most prevalent reasons for hospital admission were surgery, urinary tract infection, cancer-related condition, and gastrointestinal condition. Reasons for hospital admission by RHWP participants are summarized in Table 38.

The year of the last ED visit was reported by 31 participants at baseline. The majority (68%) of participants visited the ED in 2012 (26%) or 2013 (42%). The ED used was primarily either a HCA hospital or a Bon Secours hospital. Common reasons provided for ED use were falls, urinary tract infection, or auto accident. Reasons for ED use by RHWP participants are summarized in Table 39.

Table 37. Use of health services by 2014 RHWP participants (n=97)	
Use of Health Services	**Mean (SD), Range**
Mean number of RHWP visits per participant	11.5 (8.7), 1-35
PCP visit	**n (%)**
Year of last PCP visit (n=60)	
2014	14 (23.3)
2013	24 (40.0)
2012	22 (36.6)
Hospitalization	
Year of last hospital admission (n=43)	
2014	9 (20.9)
2013	9 (20.9)
2012	9 (20.9)
1992-2011	16 (37.2)
Location of last hospital admission (n=29)[a]	
HCA Hospital	10 (34.5)
Bon Secours Hospital	9 (31.0)
VCU Health System	7 (24.1)
McGuire VA Medical Center	2 (6.9)
Other	1 (3.5)
Number of times to the hospital in the last 6 months (n=24)	
0	16 (66.7)
1	4 (16.7)
2	1 (4.2)
3	2 (8.3)
5	1 (4.2)
ED visit	
Year of last ED visit (n=31)	
2014	4 (12.9)
2013	13 (41.9)
2012	8 (25.8)
2008-2011	6 (19.4)
Location of ED visit (n=15) [b]	
HCA Hospital	5 (33.3)
VCU Health System	5 (33.3)
Bon Secours Hospital	4 (26.7)
McGuire VA Medical Center	1 (6.7)

[a] Location of last hospital admission HCA Hospital category includes: Retreat Hospital (5), Henrico Doctor's Hospital (4), and Chippenham Hospital (1); Bon Secours Hospital category includes: St. Mary's Hospital (5), Richmond Community Hospital (2), Bon Secours Health System (1), and Bon Secours Regional Medical Center (1)
[b] Location of last hospital admission HCA Hospital category includes: Retreat Hospital (3), Henrico Doctor's Hospital (2); Bon Secours Hospital category includes: Richmond Community Hospital (2), Bon Secours Regional Medical Center (1), and St. Mary's Hospital (1)

Table 38. Reasons for last hospitalization in 2014 RHWP participants (n=50)	
Reason for hospitalization[a]	**Number (n)**
Surgery[b]	9
Urinary tract infection	3
Cancer-related	3
Gastrointestinal	3
Hypertension	2
Shortness of breath	2
Abdominal pain	2
Broken bone	2
Diabetes	2
Fall	2
Mental-health related	2
Seizure	2
Pneumonia	2
Other[c]	17

[a] Participant may have had more than one reason for hospitalization
[b] Surgery types included: knee (4), gallbladder (2), hip (1), back (1), and heart (1)
[c] Other reasons for hospitalization (all n=1): deep vein thrombosis, myocardial infarction, auto accident, bladder prolapse, bowel obstruction, chest pain, cirrhosis, hernia, kidney dysfunction, leg inflammation, mammogram/pap smear, medication allergy, migraine, rash, swelling-eye and ankle, blood transfusion, cardiac blackout

Table 39. Reasons for ED visit in 2014 RHWP participants (n=31)	
Reason for ED visit[a]	**Number (n)**
Fall	4
Urinary tract infection	3
Auto accident	3
Shortness of breath	2
Abdominal pain	2
Constipation	2
Seizure	2
Out of medication	2
Other[b]	17

[a] Participant may have had more than one reason for ED visit
[b] Other reasons for ED visits (all n=1): arthritis, broken bone, bronchitis, chest pain, cough, diarrhea, dizziness, gastrointestinal, hand stiffness, hypertension, laceration, leg inflammation, pain, pneumonia, mental health-related, vaginal bleeding, and vertigo

Visit information from the CCT

A total of 526 RWHP 2014 visits had a completed CCT. More than one faculty discipline may have participated in a RHWP visit. Nurse practitioner faculty participated in the majority of RHWP visits (n=355, 68%) and pharmacy faculty participated in 19% of RHWP visits (n=101). The mean faculty RHWP visit time was 18 minutes (SD 17, range 2-180, n=324).

Care coordination activities or needs identified

Frequent care coordination activities or needs identified were education/counseling (53%), disease monitoring (47%), and disease or medication management (24% and 13%, respectively). Follow-up/referral management and appointment scheduling was needed in approximately 17% of visits. Prescription or supplies ordering was indicated in 20 visits (4%). Medication-related discrepancies (7%) and adherence issues (4%) were identified in the RHWP visits. No care coordination activities or needs were checked on the CCT form in 6% of the visits. Care coordination activities or needs identified in 2014 RHWP visits are summarized in Table 40.

Table 40. Care coordination activities/needs identified in 2014 RHWP visits (n=526 visits)

Care coordination activities/needs identified	n (%) [a]
Education/Counseling	279 (53.0)
Disease monitoring	246 (46.8)
Disease management	126 (24.0)
Medication management	70 (13.3)
Make appointments	58 (11.0)
Follow-up/Referral management	30 (5.7)
Reconcile discrepancies:	
Medication-related	39 (7.4)
Adherence issues	20 (3.8)
Other	11 (2.1)
Home visit	26 (4.9)

Order:	
Prescriptions/Prescription delivery	14 (2.7)
Supplies (e.g. glucometer, walker)	6 (1.1)
Home health care services	1 (0.2)
Laboratory tests	-
Other	5 (1.0)
Coordination of:	
Social Services Agencies (e.g. SSI)	11 (2.1)
Insurance	2 (0.4)
Transportation	5 (1.0)
Other	17 (3.2)
Other	25 (4.8)
Unchecked	32 (6.1)

[a] Participant may have had more than one care coordination activity or need per visit

Activities performed to fulfill care coordination needs

Common care coordination activities performed in RHWP visits were: face-to-face discussion with the RHWP participant (90%), face-to-face patient education (15%), psychosocial support (9%), emotional concerns education (8%), medication-related education (8%), disease-related education (8%), chart review (8%), and monitoring (8%). A telephone discussion with the participant's PCP, pharmacy, or hospital/clinic was needed to fulfill care coordination needs (6%, 3%, and 3% of visits, respectively). No activities performed to fulfill care coordination needs were checked in 3% of visits. Activities performed to fulfill care coordination needs in 2014 RHWP visits are summarized in Table 41.

Table 41. Activities performed to fulfill care coordination needs in 2014 RHWP visits (n=526 visits)	
Activity performed to fulfill care coordination needs	**n (%)[a]**
Face-to-face discussion with:	
RHWP participant	476 (90.4)
PCP	20 (3.8)
Social work	3 (0.6)
Pharmacy	2 (0.4)
Home care	2 (0.4)
Family/caregiver	1 (0.2)
Agency	1 (0.2)
Payer	1 (0.2)
Other	7 (1.3)
Telephone discussion with:	
PCP	33 (6.3)
Pharmacy	17 (3.2)
Hospital/clinic	14 (2.7)
Home care	5 (1.0)
RHWP participant	5 (1.0)
Social work	3 (0.6)
Family/caregiver	1 (0.2)
Agency	1 (0.2)
Other	12 (2.3)
Electronic (e-mail) communication with:	
PCP	2 (0.4)
Patient	1 (0.2)
Home care	1 (0.2)
Faxed communication with:	
Patient	3 (0.6)
Pharmacy	1 (0.2)
Written report type:	
Note	4 (0.8)
Fax	1 (0.2)
Letter	1 (0.2)
Patient education/counseling (face-to-face)	78 (14.8)
Psychosocial support	49 (9.3)
Practical concerns (e.g. financial, insurance, transportation)	26 (4.9)
Family/support system concerns	9 (1.7)
Emotional concerns (e.g. distress, depression, anxiety)	40 (7.6)
Medication-related	41 (7.8)
Disease-related	35 (6.7)
Other	21 (4.0)
Chart review	36 (6.8)

Monitoring	35 (6.7)
Home visit	18 (3.4)
Develop/modify written care plan	10 (1.9)
Social work assessment	2 (0.4)
Form processing	1 (0.2)
Patient-focused research	1 (0.2)
Meeting/case conference	1 (0.2)
Other	10 (1.9)
Unchecked	15 (2.9)

[a] Participant may have had more than one care coordination activity performed per visit

Outcomes prevented in RHWP visits

Outcomes prevented (type and number) and the mean degree of certainty of the outcome prevention in 2014 RHWP visits are summarized in Table 42. The majority of visits did not have a prevented outcome checked (68%). RHWP faculty indicated their degree of certainty (range from 1 (not at all certain) to 4 (very certain)) for the prevented outcome. The most common outcome prevented was an ED visit (21%), with a mean degree of certainty of 2.7. Inappropriate medication use (15% and adverse drug event (12%) had the highest mean degree of certainty for the prevented outcome (mean 3.0).

Table 42. Outcomes prevented in 2014 RWHP visits (n=526 visits)		
Outcome Prevented	**n(%)[a]**	**Degree of Certainty of Prevented Outcome 1 (Not at all Certain) – 4 (Very Certain) Mean (SD), Range**
ED visit	111 (21.1)	2.7 (1.11), 1-4
Inappropriate medication use	78 (14.8)	3.0 (1.19), 1-4
Subspecialist visit	74 (14.1)	2.5 (1.17), 1-4
Visit to PCP office/clinic	73 (13.9)	2.6 (1.15), 1-4
Hospitalization (admission)	67 (12.7)	2.6 (1.14), 1-4
Adverse drug event	64 (12.2)	3.0 (1.18), 1-4
Nursing home stay	39 (7.4)	2.7 (1.30), 1-4
Lab/X-ray	35 (6.7)	2.4 (1.40), 1-4
Specialized therapies (PT, OT, etc.)	31 (5.9)	2.6 (1.50), 1-4
Other	32 (6.1)	2.8 (1.27), 1-4
Unchecked	324 (61.6)	-

[a] Visit may have had more than one outcome prevented.

Outcomes occurred in RHWP visits

Outcomes that occurred in 2014 RHWP visits are summarized in Table 43. Common outcomes that occurred in RHWP visits were: met patient's immediate needs, questions, concerns (41%), advised family/patient on home management (23%), referral for PCP visit (7%), advocacy for patient (6%), and reconciled discrepancies (5%). An outcome occurred was not checked in 11% of visits.

Table 43. Outcomes occurred in 2014 RHWP visits (n=526 visits)	
Outcomes occurred[a]	**n (%)**
Met patient's immediate needs, questions, concerns	215 (40.9)
Advised family/patient on home management	123 (23.4)
Referral for PCP office visit	37 (7.0)
Advocacy for patient	30 (5.7)
Reconciled discrepancies (including missing data, miscommunications, adherence issues, medication issues)	28 (5.3)
Patient knowledge or skill	25 (4.8)
Referral to social work on site	12 (2.3)
Ordered prescription, equipment, etc.	12 (2.3)

Referral to subspecialist	11 (2.1)
Referral to psych. (LCSW, LMFT, LPC, etc.)	7 (1.3)
Referral to community agency	6 (1.1)
Reviewed labs, specialist reports, etc.	6 (1.1)
Outcome pending	6 (1.1)
Referral to support group	5 (1.0)
Referral to RHWP Wellness Clinic	5 (1.0)
Unmet needs	5 (1.0)
Referral to ER	4 (0.8)
Referral to specialized therapies	4 (0.8)
Referral for hospitalization	2 (0.4)
Referral to RHWP Behavioral Health Clinic	2 (0.4)
Referral to lab/ x-ray	2 (0.4)
Referral to APS	1 (0.2)
Other	39 (7.4)
Unchecked	61 (11.2)

[a] More than one outcome may have occurred per visit.

3.3 Aim 3

Analyses from aims 3A-3C utilizing VCUHS ED electronic medical record data and billing records from 2010-2013 for community-dwelling older adults are presented in this section. The following flow chart provides the number of ED visits excluded based upon address, admission source, admission mode, discharge disposition, and duplicate records (Figure 3). A total of 7,805 ED visits were included in this study.

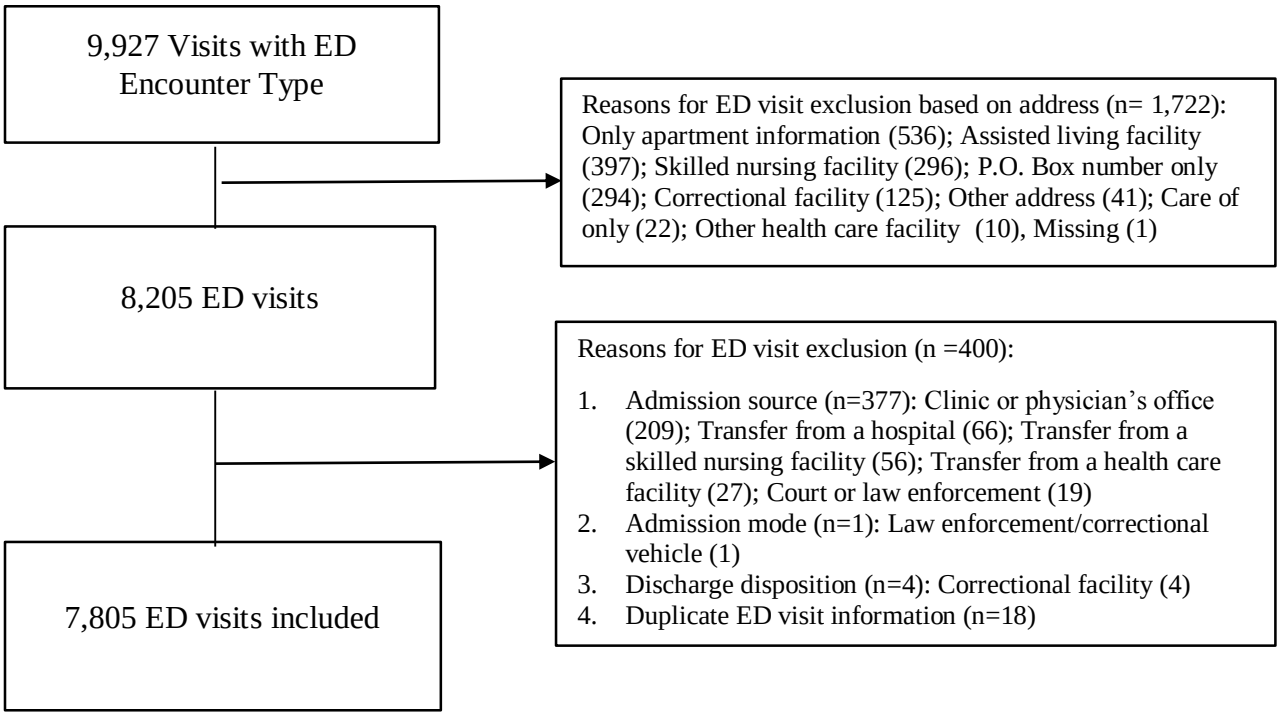


Figure 3. Flow chart for inclusion of ED encounters

3.3.1 Aim 3A

Descriptive results of the demographics and ED visit characteristics are summarized in this section. The mean (SD), range for continuous variables and the frequency (%) for categorical variables grouped by all ED visits, ED visits from zip code 23220, and ED visits from the health care hot spot address are presented in Table 44. A total of 7,805 ED visits from community-dwelling older adults were included, of which 484 were from zip code 23220 and 104 ED visits were from the health care hot spot.

The overall mean age was 73 years (SD 7.1) for all ED visits. In zip code 23220, the largest number of visits was from the age group of 65-67 years (29%); whereas, the largest number of ED visits from the health care hot spot was from the age category of 68-71 years (33%). The majority of ED visits in each group were by females (54-62%), African-American race (75-84%), and non-Hispanic/Latino/ Spanish ethnicity (98- 99%). The majority of ED encounters had Medicare as the payment source (76-85%). A higher proportion of the health care hot spot residents had Medicaid insurance (11% vs. 4% zip code 23220, 2% all ED visits) and Medicare/Medicaid insurance (3% vs 1% zip code 23220, 1% all ED visits). Over 30% of ED encounters had a CCI score of 0. ED visits from the health care hot spot had a higher proportion with a CCI score of ≥ 4 (16%) compared to the zip code 23220 (10%) and all ED visits group (13%), indicating a higher level of comorbidity in ED visits in the health care hot spot residents. The mean total disease count per ED visit was 6 (SD 4.4), range 1-42. A potentially inappropriate medication (PIM) was ordered in the ED in less than a third of ED visits (28-31%). If a PIM was present, usually only one PIM was ordered. The most common mode of arrival was

self or private transportation (64-72%) and most discharge dispositions were to home or self-care (93-95%). ED visits from the health care hot spot had a higher proportion of arrival by ambulance (37%) versus ED visits from zip code 23220 (32%) or all ED visits (28%). The percentage of ED visits by a frequent ED user was 14% overall, 12% for zip code 23220, and 19% for the health care hot spot. Almost half of all ED visits were classified as non-emergent. The average cost per ED visit was $611 adjusted to 2014 dollars.

Table 44. Demographics and ED visit characteristics by encounter for VCUHS ED, 2010-2013

Variables	All ED visits (n=7,805) Mean (SD), Range or n (%)	ED visits from zip code 23220 (n=484) Mean (SD), Range or n (%)	ED visits from hot spot address (n=104) Mean (SD), Range or n (%)
Age (years)	73.2 (7.1), 65-103	73.3 (7.6), 65-103	71.7 (5.8), 65-87
Age by quartile	**n=7,805**	**n=484**	**n=104**
65-67 years	2,005 (25.7)	142 (29.3)	27 (26.0)
68-71 years	1,956 (25.1)	116 (24.0)	34 (32.7)
72-78 years	2,076 (26.6)	98 (20.3)	27 (26.0)
≥ 79 years	1,768 (22.7)	128 (26.5)	16 (15.4)
Gender	**n=7,805**	**n=484**	**n=104**
Female	4,819 (61.7)	302 (62.4)	56 (53.9)
Male	2,986 (38.3)	182 (37.6)	48 (46.2)
Race	**n=7,805**	**n=484**	**n=104**
Black or African-American	5,840 (74.8)	407 (84.1)	87 (83.7)
White	1,655 (21.2)	54 (11.2)	11 (10.6)
Other	253 (3.2)	20 (4.1)	6 (5.8)
Asian	50 (0.6)	3 (0.6)	-
Unknown	7 (0.1)	-	-
Ethnicity	**n=7,653**	**n=479**	**n=102**
Not Hispanic-Latino-Spanish origin	7,523 (98.3)	471 (98.3)	101 (99.0)
Hispanic-Latino-Spanish origin	124 (1.6)	8 (1.7)	1 (1.0)
Unknown	6 (0.1)	-	-

Payment source[a]	**n=7,803**	**n=484**	**n=104**
Medicare	6,625 (84.9)	418 (86.4)	79 (76.0)
Other	424 (5.4)	22 (4.6)	7 (6.7)
Virginia Coordinated Care	197 (2.5)	6 (1.2)	4 (3.9)
Medicare, Other	172 (2.2)	8 (1.7)	-
Medicaid	135 (1.7)	19 (3.9)	11 (10.6)
Indigent	107 (1.4)	2 (0.4)	-
Medicare , Medicaid	75 (1.0)	5 (1.0)	3 (2.9)
Self-pay	68 (0.9)	4 (0.8)	-
Charlson Comorbidity Index Score	**n=7,420**	**n=462**	**n=100**
0	2,303 (31.0)	151 (32.7)	47 (47.0)
1	2,194 (29.6)	155 (33.6)	18 (18.0)
2	1,177 (15.9)	49 (10.6)	5 (5.0)
3	819 (11.0)	63 (13.6)	14 (14.0)
≥ 4	927 (12.5)	44 (9.5)	16 (16.0)
Total disease count by quartile	**n=7,420**	**n=462**	**n=100**
1-3	2,097 (28.3)	137 (29.7)	32 (32.0)
4-6	2,169 (29.2)	150 (32.5)	35 (35.0)
7-9	1,449 (19.5)	96 (20.8)	21 (21.0)
≥ 10	1,705 (23.0)	79 (17.1)	12 (12.0)
Total disease count	6.6 (4.4), 1-42	6.1 (3.9), 1-19	5.8 (4.2), 1-19
PIM ordered in ED	**n=5,783**	**n=364**	**n=80**
Yes	1,710 (29.6)	114 (31.3)	22 (27.5)
No	4,073 (70.4)	250 (68.7)	58 (72.5)
Number of PIM ordered in ED[b]	**n=5,783**	**n=364**	**n=80**
0	4,073 (70.4)	250 (68.7)	59 (73.8)
1	1,397 (24.2)	92 (25.3)	17 (21.3)
2	273 (4.7)	15 (4.1)	1 (1.3)
3-5	40 (0.7)	7 (1.9)	3 (3.8)
Mode of arrival to ED	**n=7,803**	**n=484**	**n=104**
Self – private transportation	5,597 (71.7)	331 (68.4)	66 (63.5)
EMS	2,203 (28.2)	153 (31.6)	38 (36.5)
Helicopter	3 (0.04)	-	-
Discharge disposition	**n=7,805**	**n=484**	**n=104**
Home or self-care	7,320 (93.8)	450 (93.0)	99 (95.2)
Left AMA	329 (4.2)	23 (4.8)	3 (2.9)
Left before clinical evaluation	98 (1.3)	8 (1.7)	2 (1.9)
Expired	44 (0.6)	2 (0.4)	-
Other facility/nursing home	14 (0.2)	1 (0.2)	-
Frequent ED user	1,074 (13.8)	56 (11.6)	20 (19.2)
Year of ED visit	**n=7,805**	**n=484**	**n=104**
2010	1,726 (22.1)	105 (21.7)	35 (33.7)
2011	1,828 (23.4)	105 (21.7)	17 (16.4)
2012	2,068 (26.5)	132 (27.3)	20 (19.2)
2013	2,183 (28.0)	142 (29.3)	32 (30.8)
Zip code 23220	484 (6.2)	484 (100.0)	104 (100.0)

Hot spot apartment building	104 (1.3)	104 (21.5)	104 (100.0)
NYU ED Algorithm visit category	**n=7,805**	**n=484**	**n=104**
Non-Emergent	3,871 (49.6)	244 (50.4)	50 (48.1)
Injury	1,274 (16.3)	81 (16.7)	20 (19.2)
Emergent	1,179 (15.1)	77 (15.9)	19 (18.3)
Mental health related	124 (1.6)	4 (0.8)	-
Intermediate	115 (1.5)	9 (1.9)	2 (1.9)
Alcohol-related	21 (0.3)	1 (0.2)	-
Drug-related (excludes alcohol)	5 (0.1)	-	-
Not in a special category, not classified	1,216 (15.6)	68 (14.1)	13 (12.5)
Total ED costs ($)[c]	$611 ($674), $0-$29,835	$620 ($537), $0-$2,973	$555 ($433), $0-$2,237

[a] Some payment source categories were collapsed due to small sample size. There were n=5 ED visits with Medicaid, Other and n=2 ED visits with Medicaid, Tricare collapsed into the Medicaid payment source category, n=2 ED visits with Medicare, Medicaid, Other payment source collapsed into the Medicare, Medicaid category, n= 9 ED visits with Medicare, Tricare collapsed into the Medicare, Other category, and n= 3 ED visits with Tricare/VA only collapsed into the Other category.
[b] PIM= Potentially Inappropriate Medication
[c] Costs rounded to nearest dollar

CCI scores were calculated for ED encounters with problem lists (7,420 out of 7,805 visits, 4.9% missing). The number of visits in each diagnostic category is summarized in Table 45. About one-third of ED encounters had myocardial infarction (37%) or mild to moderate diabetes (33%) as a comorbid condition. More ED encounters from the health care hot spot ED visit group had cerebrovascular disease (26%) and peripheral vascular disease (13%) versus all ED visits and visits from zip code 23220 (both 14% for cerebrovascular disease and 4-7% for peripheral vascular disease). Congestive heart failure was a comorbid condition in 22% of zip code 23220 ED visits compared to 18% of health care hot spot ED visits and 19% of all ED visits.

Table 45. Charlson Comorbidity Index diagnostic category by encounter for VCUHS ED, 2010-2013			
Charlson Comorbidity Index Diagnostic Category	**All ED visits (n=7,420) n (%)**	**ED visits from zip code 23220 (n=462) n (%)**	**ED visits from hot spot address (n=100) n (%)**
Myocardial infarction	2,707 (36.5)	149 (32.3)	33 (33.0)
Diabetes (mild to moderate)	2,434 (32.8)	143 (31.0)	32 (32.0)
Congestive heart failure	1,424 (19.2)	103 (22.3)	18 (18.0)
Chronic pulmonary disease	1,079 (14.5)	59 (12.8)	7 (7.0)
Cerebrovascular disease	1,000 (13.5)	65 (14.1)	26 (26.0)
Renal disease	981 (13.2)	59 (12.8)	17 (17.0)
Any malignancy, including lymphoma and leukemia	907 (12.2)	49 (10.6)	11 (11.0)
Peripheral vascular disease	298 (4.0)	34 (7.4)	13 (13.0)
Rheumatologic disease	232 (3.1)	11 (2.4)	2 (2.0)
Diabetes with chronic complications	191 (2.6)	15 (3.3)	4 (4.0)
Mild liver disease	136 (1.8)	9 (2.0)	-
Dementia	69 (0.9)	8 (1.7)	-
Metastatic solid tumor	66 (0.9)	1 (0.2)	-
Peptic ulcer disease	62 (0.8)	6 (1.3)	4 (4.0)
Moderate or severe liver disease	23 (0.3)	1 (0.2)	-
Hemiplegia or paraplegia	23 (0.3)	-	-
AIDS	-	-	-

The top 20 primary ED visit diagnosis codes (ICD-9-CM) for all ED visits are provided in Table 46. The most common primary ED visit diagnoses were chest pain, abdominal pain, no procedure/patient decision, and dizziness and giddiness.

Table 46. Top 20 primary diagnosis codes for all ED visits: VCUHS ED, 2010-2013

ICD-9-CM Code	ICD-9-CM Code Description	All ED Visits with an ICD-9-CM code (n=7,730) n (%)
786.50	Chest pain, not otherwise specified (NOS)	405 (5.2)
789.09	Abdominal pain, other specific site	284 (3.7)
V64.2	No procedure/patient decision	260 (3.4)
780.4	Dizziness and giddiness	201 (2.6)
786.09	Respiratory abnormality, not elsewhere classified (NEC)	179 (2.3)
599.0	Urinary tract infection NOS	173 (2.2)
784.0	Headache	158 (2.0)
786.59	Chest pain NEC	141 (1.8)
780.79	Other malaise and fatigue	135 (1.8)
724.2	Lumbago	131 (1.7)
729.5	Pain in limb	119 (1.5)
401.9	Hypertension NOS	103 (1.3)
959.01	Head injury	102 (1.3)
789.00	Abdominal pain, unspecified site	78 (1.0)
780.2	Syncope and collapse	73 (0.9)
780.97	Altered mental status	70 (0.9)
847.0	Sprain of neck	70 (0.9)
786.05	Shortness of breath	68 (0.9)
719.41	Joint pain- shoulder	67 (0.9)
784.7	Epistaxis	64 (0.8)

Similarly, the top 20 primary diagnosis codes for ED visits from zip code 23220 are summarized in Table 47. In ED visits from zip code 23220, chest pain, abdominal pain, no procedure/patient decision, and headache were the most common primary diagnoses.

Table 47. Top 20 primary diagnosis codes for ED visits from zip code 23220: VCUHS ED, 2010-2013		
ICD-9-CM Code	**ICD-9-CM Code Description**	**ED visits from zip code 23220 with an ICD-9-CM Code (n=477) n (%)**
786.50	Chest pain NOS	26 (5.5)
786.59	Chest pain NEC	16 (3.4)
789.09	Abdominal pain, other specific site	16 (3.4)
V64.2	No procedure/patient decision	16 (3.4)
784.0	Headache	13 (2.7)
599.0	Urinary tract infection NOS	12 (2.5)
780.4	Dizziness and giddiness	11 (2.3)
786.09	Respiratory abnormality NEC	11 (2.3)
401.9	Hypertension NOS	10 (2.1)
959.01	Head injury	9 (1.9)
682.6	Cellulitis of leg	7 (1.5)
724.2	Lumbago	7 (1.5)
729.5	Pain in limb	7 (1.5)
784.7	Epistaxis	7 (1.5)
491.21	Chronic bronchitis with exacerbation	5 (1.1)
493.92	Asthma, unspecified acute	5 (1.1)
719.41	Joint pain – shoulder	5 (1.1)
780.79	Other malaise and fatigue	5 (1.1)
786.2	Cough	5 (1.1)
786.52	Painful respiration	5 (1.1)

The most common primary diagnosis ICD-9-CM codes for ED visits from the health care hot spot address were chest pain NOS (786.50) and respiratory abnormality NEC (786.09), with 6 (5.9%) and 5 visits (4.9%) respectively.

PIMs ordered during ED encounters are listed in Table 48. Medications were ordered in 5,783 of the 7,805 ED visits included in this study (2,022 ED visits missing, 26%). The two most common PIMs ordered in the ED were ibuprofen and diazepam (495 and 275 ED visits, respectively).

Table 48. Potentially inappropriate medications for older adults ordered in ED visits (n=5,783), VCUHS ED, 2010-2013			
Medication	**n (%)**	**Medication**	**n (%)**
Anticholinergics		***Central nervous system (cont.)***	
Diphenhydramine	88 (1.52)	Barbiturates	
Hydroxyzine	24 (0.42)	Butalbital	111 (1.92)
Promethazine	11 (0.19)	Phenobarbital	4 (0.07)
Chlorpheniramine	6 (0.l0)	Benzodiazepines	
Antiparkinson agents		Diazepam	275 (4.76)
Benztropine	1 (0.02)	Lorazepam	94 (1.63)
Antispasmodics		Alprazolam	14 (0.24)
Scopolamine	5 (0.09)	Clonazepam	11 (0.19)
Dicyclomine	3 (0.05)	Chlordiazepoxide	3 (0.05)
Hyoscyamine	3 (0.05)	Temazepam	1 (0.02)
Antithrombotics		Nonbenzodiazepine hypnotics	
Dipyridamole	4 (0.07)	Zolpidem	8 (0.14)
Ticlopidine	1 (0.02)	***Endocrine***	
Anti-infective		Insulin	118 (2.04)
Nitrofurantoin	63 (1.09)	Glyburide	5 (0.09)
Cardiovascular		Megestrol	3 (0.05)
		Estrogens with/without	
Alpha1 blockers		Progestins	2 (0.03)
Doxazosin	4 (0.07)	Testosterone	1 (0.02)
Prazosin	1 (0.02)	***Gastrointestinal***	
Alpha agonists, central		Metoclopramide	24 (0.42)
Clonidine	49 (0.85)	Mineral oil	7 (0.12)
Antiarrhythmic drugs		***Pain***	
Amiodarone	3 (0.05)	Meperidine	1 (0.02)
Propafenone	1 (0.02)	Non-COX-selective NSAIDSs	
Sotalol	1 (0.02)	Ibuprofen	495 (8.56)
Spironolactone	4 (0.07)	Aspirin	220 (3.80)
Nifedipine	2 (0.03)	Naproxen	99 (1.71)
Digoxin	1 (0.02)	Diclofenac	11 (0.19)
Central nervous system		Ketoprofen	1 (0.02)
Amitriptyline	4 (0.07)	Ketorolac	117 (2.02)
Antipsychotics		Indomethacin	34 (0.59)
Quetiapine	9 (0.16)	Skeletal muscle relaxants	
Haloperidol	8 (0.14)	Methocarbamol	54 (0.93)
Chlorpromazine	6 (0.10)	Cyclobenzaprine	40 (0.69)
Promazine	6 (0.10)	Carisoprodol	3 (0.05)
Risperidone	4 (0.07)		
Ziprasidone	2 (0.03)		
Olanzapine	1 (0.02)		

Demographics and ED visit characteristics grouped by non-emergent, emergent, intermediate, and all (non-emergent, emergent, and intermediate) NYU ED algorithm categories are summarized in Table 49. There were a total of 5,165 ED visits that were categorized as either non-emergent (n=3,871), emergent (n=1,179), or intermediate (n=115) by the NYU ED algorithm. The overall mean age was 73 years (SD 7.0) for all ED, non-emergent, and emergent ED visits; whereas the mean age was 72 years (SD 6.0) for the intermediate ED visits. The majority of ED visits were by females, African-Americans, and non-Hispanic/Latino/Spanish ethnicity. Females had a larger percentage of non-emergent (65%) versus emergent (61%) or intermediate (57%) ED visits. The majority of ED encounters had Medicare as the payment source (84-90%). A higher proportion of emergent (34%) and intermediate (38%) ED visits had a CCI score of 1 versus non-emergent (30%) or all ED visits (31%). Additionally, emergent ED visits had a higher proportion with a CCI score of ≥ 4 (15%) compared to non-emergent (11%), intermediate (13%), and all ED visits (12%). Emergent and non-emergent ED visits had the category of 4-6 total disease count as the most prevalent (33% and 30%, respectively). A PIM was ordered in less than one-third of ED visits (16-31%). The most common mode of arrival was self or private transportation (61-78%). Emergent ED visits had a higher proportion of arriving by ambulance (39%) compared to non-emergent, intermediate, and all ED visits. (23%, 31%, 27%, respectively). Most discharge dispositions were to home or self-care. The discharge disposition of expired was only present in emergent ED visits. The percentage of ED visits by a frequent ED user was 14% of non-emergent, 16% of emergent, 27% of intermediate ED visits. There were a total of 330 ED visits from patients living in zip code 23220, of which 244 were non-emergent (74%), 77 were emergent (23%), and 9 were intermediate (3%) ED visits. A total of 71 ED visits were from the health care hot spot, of which 50 were non-emergent (70%), 19

were emergent (27%), and 2 were intermediate (3%) ED visits. The mean cost per ED visit was $643 (adjusted to 2014 dollars). Non-emergent ED visits had a lower mean cost ($549) than emergent ($947) or intermediate ($687) ED visits.

Table 49. Demographics and ED visit characteristics by NYU ED algorithm category: VCUHS ED, 2010-2013

Variables	Non-Emergent, Emergent, and Intermediate ED visits (n=5,165) Mean (SD), Range or n (%)	Non-Emergent ED Visits (n=3,871) Mean (SD), Range or n (%)	Emergent ED Visits (n=1,179) Mean (SD), Range or n (%)	Intermediate ED Visits (n=115) Mean (SD), Range or n (%)
Age (years)	72.9 (7.0), 65-103	72.9 (7.0), 65-103	73.0 (6.9), 65-99	72.2 (6.0), 65-89
Age by quartile	**n=5,165**	**n=3,871**	**n=1,179**	**n=115**
65-67 years	1,382 (26.8)	1,055 (27.3)	295 (25.0)	32 (27.8)
68-71 years	1,317 (25.5)	970 (25.1)	316 (26.8)	31 (27.0)
72-78 years	1,350 (26.1)	1,002 (25.9)	311 (26.4)	37 (32.2)
≥ 79 years	1,116 (21.6)	844 (21.8)	257 (21.8)	15 (13.0)
Gender	**n=5,165**	**n=3,871**	**n=1,179**	**n=115**
Female	3,281 (63.5)	2,498 (64.5)	717 (60.8)	66 (57.4)
Male	1,884 (36.5)	1,373 (35.5)	462 (39.2)	49 (42.6)
Race	**n=5,165**	**n=3,871**	**n=1,179**	**n=115**
Black or African-American	3,994 (77.3)	3,009 (77.7)	895 (75.9)	90 (78.3)
White	971 (18.8)	707 (18.3)	242 (20.5)	22 (19.1)
Other	161 (3.1)	122 (3.2)	37 (3.1)	2 (1.7)
Asian	34 (0.7)	29 (0.8)	4 (0.3)	1 (0.9)
Unknown	5 (0.1)	4 (0.1)	1 (0.08)	-
Ethnicity	**n=5,068**	**n=3,801**	**n=1,153**	**n=114**
Not Hispanic-Latino-Spanish origin	4,976 (98.2)	3,735 (98.3)	1,129 (97.9)	112 (98.3)
Hispanic-Latino-Spanish origin	88 (1.7)	63 (1.7)	23 (2.0)	2 (1.8)
Unknown	4 (0.1)	3 (0.1)	1 (0.1)	-
Payment source	**n=5,165**	**n=3,871**	**n=1,179**	**n=115**
Medicare	4,371 (84.6)	3,256 (84.1)	1,012 (85.8)	103 (89.6)
Other	277 (5.4)	210 (5.4)	62 (5.3)	5 (4.4)
Virginia Coordinated Care	131 (2.5)	101 (2.6)	28 (2.4)	2 (1.7)
Medicare, Other	117 (2.3)	91 (2.4)	23 (2.0)	3 (2.6)
Medicaid	94 (1.8)	72 (1.9)	20 (1.7)	2 (1.7)
Indigent	84 (1.6)	71 (1.8)	13 (1.1)	-
Medicare , Medicaid	46 (0.9)	34 (0.9)	12 (1.0)	-
Self-pay	45 (0.9)	36 (0.9)	9 (0.8)	-

CCI Score[a]	**n=4,940**	**n=3,692**	**n=1,135**	**n=113**
0	1,481 (30.0)	1,166 (31.6)	288 (25.4)	27 (23.9)
1	1,524 (30.9)	1,095 (29.7)	386 (34.0)	43 (38.1)
2	789 (16.0)	597 (16.2)	171 (15.1)	21 (18.6)
3	557 (11.3)	432 (11.7)	118 (10.4)	7 (6.2)
≥ 4	589 (11.9)	402 (10.9)	172 (15.2)	15 (13.3)
Total disease count by quartile	**n=4,940**	**n=3,692**	**n=1,1135**	**n=113**
1-3	1,327 (26.9)	1,044 (28.3)	259 (22.8)	24 (21.2)
4-6	1,499 (30.3)	1,096 (29.7)	375 (33.0)	28 (24.8)
7-9	993 (20.1)	734 (19.9)	234 (20.6)	25 (22.1)
≥ 10	1,121 (22.7)	818 (22.2)	267 (23.5)	36 (31.9)
Total disease count	6.3 (4.4), 1-42	6.5 (4.3), 1-42	7.0 (4.7),1-27	7.6 (4.6),1-19
PIM ordered in ED[b]	**n=3,928**	**n=2,940**	**n=887**	**n=101**
Yes	1,140 (29.0)	846 (28.8)	278 (31.3)	16 (15.8)
No	2,788 (71.0)	2,094 (71.2)	609 (68.7)	85 (84.2)
Number of PIM ordered in ED[b]	**n=3,928**	**n=2,490**	**n=887**	**n=101**
0	2,788 (71.0)	2,094 (71.2)	609 (68.7)	85 (84.2)
1	949 (24.2)	698 (23.7)	236 (26.6)	15 (14.9)
2	168 (4.3)	131 (4.5)	36 (4.1)	1 (1.0)
3-5	23 (0.6)	17 (0.6)	6 (0.7)	-
Mode of arrival to ED	**n=5,163**	**n=3,781**	**n=1,177**	**n=115**
Self – private transportation	3,792 (73.5)	2,998 (77.5)	715 (60.8)	79 (68.7)
EMS	1,370 (26.5)	872 (22.5)	462 (39.3)	36 (31.3)
Helicopter	1 (0.02)	1 (0.03)	-	-
Discharge disposition	**n=5,165**	**n=3,871**	**n=1,179**	**n=115**
Home or self-care	4,778 (92.5)	3,564 (92.1)	1,103 (93.6)	111 (96.5)
Left AMA	258 (5.0)	224 (5.8)	31 (2.6)	3 (2.6)
Left before clinical evaluation	85 (1.7)	81 (2.1)	3 (0.3)	1 (0.9)
Expired	39 (0.8)	-	39 (3.31)	-
Other facility/ nursing home	5 (0.1)	2 (0.1)	3 (0.3)	-
Frequent ED user	763 (14.8)	539 (13.9)	193 (16.4)	31 (27.0)
Year of ED visit	**n=5,165**	**n=3,871**	**n=1,179**	**n=115**
2010	1,232 (23.9)	911 (23.5)	306 (26.0)	15 (13.0)
2011	1,232 (23.9)	915 (23.6)	295 (25.0)	22 (19.1)
2012	1,329 (25.7)	1,016 (26.3)	281 (23.8)	32 (27.8)
2013	1,372 (26.6)	1,029 (26.6)	297 (25.2)	46 (40.0)
Zip code 23220	330 (6.4)	244 (6.3)	77 (6.5)	9 (7.8)
Hot spot residence	71 (1.4)	50 (1.3)	19 (1.6)	2 (1.7)
Total costs ($) [c]	$643 ($580), $0-$11,901	$549 ($502), $0-$3,341	$947 ($709), $0-$11,901	$687 ($460), $0-$2,058

[a] CCI = Charlson Comorbidity Index

[b] PIM = Potentially Inappropriate Medication

[c] Costs rounded to nearest dollar

The top twenty primary diagnosis ICD-9-CM codes for non-emergent ED visits are summarized in Table 50. Abdominal pain, no procedure/patient decision, dizziness and giddiness, respiratory abnormality, urinary tract infection, and headache were the most common primary diagnoses in non-emergent ED visits.

Table 49. Top 20 primary diagnosis codes for non-emergent ED visits: VCUHS ED, 2010-2013

ICD-9-CM Code	ICD-9-CM Code Description	Non-Emergent ED Visits (n=3,871) n (%)
789.09	Abdominal pain, other specific site	284 (7.3)
V64.2	No procedure/patient decision	260 (6.7)
780.4	Dizziness and giddiness	201 (5.2)
786.09	Respiratory abnormality NEC	179 (4.6)
599.0	Urinary tract infection NOS	173 (4.5)
784.0	Headache	158 (4.1)
786.59	Chest pain NEC	141 (3.6)
780.79	Other malaise and fatigue	135 (3.5)
724.2	Lumbago	131 (3.4)
729.5	Pain in limb	119 (3.1)
401.9	Hypertension NOS	103 (2.7)
789.00	Abdominal pain, unspecified site	78 (2.0)
719.41	Joint pain, shoulder	67 (1.7)
784.7	Epistaxis	64 (1.7)
719.45	Joint pain, pelvis	55 (1.4)
724.5	Backache NOS	50 (1.3)
786.2	Cough	46 (1.2)
719.46	Joint pain, lower leg	45 (1.2)
789.06	Abdominal pain, epigastric	44 (1.1)
787.01	Nausea with vomiting	44 (1.1)

The top twenty primary diagnosis ICD-9-CM codes for emergent ED visits are summarized in Table 51. Chest pain, syncope and collapse, shortness of breath, type II diabetes with other specified manifestations, and palpitations were the most common primary diagnoses in emergent ED visits.

Table 50. Top 20 primary diagnosis codes for emergent ED visits: VCUHS ED, 2010-2013		
ICD-9-CM Code	ICD-9-CM Code Description	Emergent ED Visits (n =1,179) n (%)
786.50	Chest pain NOS	405 (34.4)
780.2	Syncope and collapse	73 (6.2)
786.05	Shortness of breath	68 (5.8)
250.80	Diabetes with other specified manifestations, type II	56 (4.8)
785.1	Palpitations	53 (4.5)
493.92	Asthma, unspecified acute	44 (3.7)
486.	Pneumonia, organism unspecified	40 (3.4)
428.0	Congestive heart failure	37 (3.1)
493.90	Asthma, without status	32 (2.7)
780.39	Other convulsions	32 (2.7)
427.5	Cardiac arrest	27 (2.3)
276.7	Hyperpotassemia	23 (2.0)
427.31	Atrial fibrillation	20 (1.7)
435.9	Transient cerebral ischemia NOS	20 (1.7)
724.3	Sciatica	19 (1.6)
427.89	Cardiac dysrhythmias NOS	15 (1.3)
724.1	Pain in thoracic spine	15 (1.3)
578.9	Gastrointestinal hemorrhage, NOS	14 (1.2)
250.81	Diabetes with other specified manifestations, type I	12 (1.0)
276.8	Hypopotassemia	12 (1.0)

The top five primary diagnosis ICD-9-CM codes for intermediate ED visits are summarized in Table 52. Chronic bronchitis with exacerbation was the most common primary diagnosis in an intermediate ED visit (46%).

Table 51. Top five primary diagnosis codes for intermediate ED visits: VCUHS ED, 2010-2013		
ICD-9-CM Code	ICD-9-CM Code Description	Intermediate ED Visits (n=115)[a] n (%)
491.21	Chronic bronchitis with exacerbation	53 (46.1)
496.	Chronic airway obstruction NEC	29 (25.2)
459.81	Venous insufficiency NOS	8 (7.0)
372.72	Conjunctival hemorrhage	6 (5.2)
708.0	Allergic urticaria	6 (5.2)

[a] Other primary diagnosis codes for Intermediate ED visits: 368.8 Visual disturbances NEC (4), 783.0 Anorexia (4), 331.0 Alzheimer's disease (2), 054.10 Genital herpes NOS, 475.Peritonsillar abscess, and 555.9 Regional enteritis NOS (all n=1 ED visit)

3.3.2 Aim 3B

The relationship between demographics and ED visit characteristics and zip code (23220) was evaluated in this aim. This aim examined both non-emergent (n=3,871) and emergent (n=1,179) visits. The results are presented by non-emergent and emergent visit analyses.

Non-emergent ED visits

There were a total of 244 non-emergent ED visits in zip code 23220. Due to small sample size (cell size < 5), unknown race and ethnicity, arrival by helicopter, and a discharge disposition of expired or other facility/nursing home were considered missing for non-emergent ED visits. Race of Asian was collapsed into the other category. The variable total ED cost was log transformed due to skewed distribution. The variables PIM ordered in the ED and PIM number (linear combination of variables), total diagnosis count and total diagnosis count by quartiles ($r>0.8$), and discharge disposition ($r>0.8$) were collinear. The Variance Inflation Factors (VIFs) for the total disease count variables were 7-11 and the discharge diagnosis variables were 7. This was above the cutoff of 4, indicating that multicollinearity was a concern in this model. The variables discharge disposition and total disease count number were removed and multicollinearity was reassessed. The resulting VIFs for the reduced model ranged from 1.0-1.8, indicating multicollinearity was not a concern. Eigenvalues and condition indexes were also examined and indications of multicollinearity were not found in the intercept adjusted model. The health care hot spot residence variable was not stable in the unadjusted or full logistic regression model (all ED visits were in the zip code 23220 yes category). Additionally, the PIM

ordered in the ED variable was not included in the full multivariable logistic regression model due to 24% missing observations. Thus, PIM ordered in the ED and discharge disposition were analyzed in an unadjusted logistic regression only. A total of 151 observations had a |R-student| >2, ranging from 3.8-4.5, indicative of an outlier. These outliers were examined in the data and no obvious error entry or cause was observed. The outliers were kept in the analyzed data set as recommended by Iglewicz and Hoagle. They state that "outliers whose causes have not clearly been determined should be used in the data analysis".[110] In addition, an outlier can come from the inherent variability of the data and may have a legitimate place remaining in the analysis.[111]

The results of chi-square tests (categorical variables) and t-tests (continuous variables) for non-emergent ED visits by zip code 23220 are summarized in Table 53. Race, CCI score, total disease count, total disease count category (e.g. 1-3), and mode of arrival to ED were statistically different by zip code 23220. Zip code 23220 had a higher proportion ED visits by Black or African-American race, CCI score of 1 or 4, total disease count category of 1-3 or 4-6, and arrival to the ED via ambulance. This health care hot spot is located in the 23220 zip code; thus, all non-emergent ED visits were in the zip code 23220 (yes) category. Age, gender, ethnicity, payment source, PIM ordered in the ED and number of PIM, discharge disposition, frequent ED user, year of ED visit, and total ED costs were not statistically different by zip code 23220.

Table 52. Demographics and ED visit characteristics by zip code 23220 for non-emergent ED visits: VCUHS ED, 2010-2013				
Variables	**Non-Emergent ED Visits (n=3,871) Mean (SD), Range or n (%)**	**Zip code 23220, NO (n=3,627) Mean (SD), Range or n (%)**	**Zip code 23220,YES (n=244) Mean (SD), Range or n (%)**	**Chi-square or t-test between zip code 23220 groups p-value**
Age (years)	72.9 (7.0), 65-103	72.9 (7.0), 65-103	73.1(7.5), 65-103	**0.6658**
Age by quartile	**n=3,871**	**n=3,627**	**n=244**	**0.2444**
65-67 years	1,055 (27.3)	980 (27.0)	75 (30.7)	
68-71 years	970 (25.1)	915 (25.2)	55 (22.5)	
72-78 years	1,002 (25.9)	948 (26.1)	54 (22.1)	
≥ 79 years	844 (21.8)	784 (21.6)	60 (24.6)	
Gender	**n=3,871**	**n=3,627**	**n=244**	**0.2970**
Female	2,498 (64.5)	2,333 (64.3)	165 (67.6)	
Male	1,373 (35.5)	1,294 (35.7)	79 (32.4)	
Race[a]	**n=3,867**	**n=3,623**	**n=244**	**<0.0001***
Black or African-American	3,009 (77.8)	2,794 (77.1)	215 (88.1)	
White	707 (18.3)	690 (19.0)	17 (7.0)	
Other	151 (3.9)	139 (3.8)	12 (4.9)	
Ethnicity[b]	**n=3,798**	**n=3,556**	**n=242**	**0.5978**
Not Hispanic-Latino-Spanish origin	3,735 (98.3)	3,496 (98.3)	239 (98.8)	
Hispanic-Latino-Spanish origin	63 (1.7)	60 (1.7)	3 (1.2)	
Payment source	**n=3,871**	**n=3,627**	**n=244**	**0.2529**
Medicare	3,256 (84.1)	3,049 (84.1)	207 (84.8)	
Other	210 (5.4)	198 (5.5)	12 (4.9)	
Virginia Coordinated Care	101 (2.6)	96 (2.7)	5 (2.1)	
Medicare, Other	91 (2.4)	84 (2.3)	7 (2.9)	
Medicaid	72 (1.9)	63 (1.7)	9 (3.7)	
Indigent	71 (1.8)	70 (1.9)	1 (0.4)	
Self-pay	36 (0.9)	34 (0.9)	2 (0.8)	
Medicare , Medicaid	34 (0.9)	33 (0.9)	1 (0.4)	
Charlson Comorbidity Index Score	**n=3,692**	**n=3,455**	**n=237**	**0.0006***
0	1,166 (31.6)	1,090 (31.6)	76 (32.1)	
1	1,095 (29.7)	1,012 (29.3)	83 (35.0)	
2	597 (16.2)	575 (16.6)	22 (9.3)	
3	432 (11.7)	392 (11.4)	40 (16.9)	
≥ 4	402 (10.9)	386 (11.2)	16 (6.8)	
Total disease count by quartile	**n=3,692**	**n=3,455**	**n=237**	**0.0198***
1-3	1,044 (28.3)	968 (28.0)	76 (32.1)	
4-6	1,096 (29.7)	1,013 (29.3)	83 (35.0)	
7-9	734 (19.9)	692 (20.0)	42 (17.7)	
≥ 10	818 (22.2)	782 (22.6)	36 (15.2)	
Total disease count	6.5 (4.3), 1-42	6.5 (4.3), 1-42	5.8 (3.8),1-19	**0.0122***

PIM ordered in ED[c]	**n=2,940**	**n=2,743**	**n=197**	**0.5894**
Yes	846 (28.8)	786 (28.7)	60 (30.5)	
No	2,094 (71.2)	1,957 (71.4)	137 (69.5)	
Number of PIM ordered in ED	**n=2,940**	**n=2,743**	**n=197**	**0.1966**
0	2,094 (71.2)	1,957 (71.4)	137 (69.5)	
1	698 (23.7)	653 (23.8)	45 (22.8)	
2	131 (4.5)	119 (4.3)	12 (6.1)	
3-5	17 (0.6)	14 (0.5)	3 (1.5)	
Mode of arrival to ED[d]	**n=3,780**	**n=3,626**	**n=244**	**0.0393***
Self – private transportation	2,998 (77.5)	2,822 (77.8)	176 (72.1)	
Ambulance	872 (22.5)	804 (22.2)	68 (27.9)	
Discharge disposition[e]	**n=3,869**	**n=3,625**	**n=244**	**0.6286**
Home or self-care	3,564 (92.1)	3,337 (92.1)	227 (93.0)	
Left AMA	224 (5.8)	213 (5.9)	11 (4.5)	
Left before clinical evaluation	81 (2.1)	75 (2.1)	6 (2.5)	
Frequent ED user	539 (13.9)	507 (14.0)	32 (13.1)	**0.7060**
Year of ED visit	**n=3,871**	**n=3,627**	**n=244**	**0.5233**
2010	911 (23.5)	862 (23.8)	49 (20.1)	
2011	915 (23.6)	859 (23.7)	56 (23.0)	
2012	1,016 (26.3)	946 (26.1)	70 (28.7)	
2013	1,029 (26.6)	960 (26.5)	69 (28.3)	
Hot spot residence	50 (1.3)	-	50 (20.5)	**<0.0001***
Total costs ($) [a]	$549 ($502), $0-$3,341	$547 ($500), $0-$3,341	$578 ($532), $0-$2,973	**0.3550**

[a] Due to small sample size, unknown race (n=4), was considered missing. Race of Asian (n=29) was collapsed into the other category.
[b] Due to small sample size, unknown ethnicity (n=3) was considered missing.
[c] PIM = Potentially Inappropriate Medication
[d] Due to small sample size, arrival to ED by helicopter (n=1) was considered missing.
[e] Due to small sample size, discharge disposition of other facility/nursing home (n=2) and expired (n=0) was considered missing.
* p <0.05

The results of the bivariate logistic regression analysis (unadjusted odds ratio (OR), 95% confidence interval (CI)) and multivariable logistic regression analysis (adjusted AOR, 95% CI) for non-emergent ED visits are summarized in Table 54. Race, CCI score, total disease count, and mode of arrival to the ED had a significant unadjusted relationship with zip code 23220. ED visits by white race patients were less likely to be from zip code 23220 (OR 0.32, 95%CI: 0.19-0.53). A CCI score of 2 or a total disease count of 10 or more was 45% and 41% less likely to be from zip code 23220 (OR 0.55, 95%CI: 0.34-0.89 and OR 0.59, 95% CI: 0.39-0.88,

respectively). Arrival to the ED via ambulance had 1.4 times the odds of residing in zip code 23220 (95% CI: 1.01-1.81). Age, gender, race, ethnicity, payment source, frequent ED use, year of ED visit, and total costs were not associated with zip code 23220.

In the adjusted model, race, CCI score, and total disease count were significant predictors of zip code 23220. ED visits by white race patients were 67% less likely to be from zip code 23220 (AOR 0.33, 95% CI: 0.19-0.57). A CCI score of 3 had 2.1 times the odds of being from zip code 23220 (95% CI: 1.32-3.34). A total disease count of 10 or more was 51% less likely to be from zip code 23220 (AOR 0.49, 95% CI: 0.30-0.81). Age, gender, ethnicity, payment source, mode of arrival, frequent ED user, year of ED visit, and total costs were not associated with zip code 23220, in the presence of all other variables.

Table 53. Demographics and ED visit characteristics predictors of zip code 23220 in non-emergent ED visits: VCUHS ED, 2010-2013				
Variables	**Unadjusted Odds Ratio (OR) (95%CI)**	**p-value[a]**	**Adjusted OR (95% CI)[b,c] (n=3,394)**	**p-value[a]**
Age by quartile	**n=3,871**	**0.2431**		**0.1994**
65-67 years	1.0		1.0	
68-71 years	0.79 (0.55-1.13)	0.1878	0.79 (0.53-1.18)	0.2488
72-78 years	0.74 (0.52-1.07)	0.1089	0.69 (0.46-1.02)	0.0626
≥ 79 years	1.00 (0.70-1.42)	1.0000	0.97 (0.66-1.43)	0.8855
Gender	**n=3, 871**	**0.2938**		**0.3084**
Female	1.0		1.0	
Male	0.86 (0.66-1.14)	0.2974	0.85 (0.62-1.16)	0.3084
Race	**n=3,867**	**<0.0001***		**0.0002***
Black or African-American	1.0		1.0	
White	0.32 (0.19-0.53)	<0.0001	0.33 (0.19-0.57)	<0.0001
Other	1.12 (0.61-2.06)	0.7098	1.53 (0.66-3.58)	0.3236
Ethnicity	**n=3, 798**	**0.5820**		**0.9291**
Not Hispanic-Latino-Spanish origin	1.0		1.0	
Hispanic-Latino-Spanish origin	0.73 (0.23-2.35)	0.6000	1.06 (0.29-3.91)	0.9291
Payment source	**n=3,871**	**0.2232**		**0.1154**
Medicare	1.0		1.0	
Other	0.89 (0.49-1.63)	0.7105	0.94 (0.49-1.81)	0.8610
Self-pay	0.87 (0.21-3.63)	0.8445	0.48 (0.06-3.66)	0.4789
Virginia Coordinated Care	0.77 (0.31-1.91)	0.5681	0.36 (0.10-1.30)	0.1203
Medicare, Other	1.23 (0.56-2.69)	0.6083	1.46 (0.65-3.29)	0.3629
Medicaid	2.10 (1.03-4.29)	0.0407	2.20 (1.05-4.59)	0.0370
Indigent	0.21 (0.03-1.52)	0.1227	0.20 (0.03-1.47)	0.1133
Medicare , Medicaid	0.45 (0.06-3.28)	0.4279	0.42 (0.06-3.14)	0.3981
Charlson Comorbidity Index Score	**n=3,692**	**0.0004***		**0.0003***
0	1.0		1.0	
1	1.18 (0.85-1.62)	0.3241	1.34 (0.94-1.92)	0.1080
2	0.55 (0.34-0.89)	0.0153	0.68 (0.40-1.16)	0.1559
3	1.46 (0.98-2.18)	0.0620	2.10 (1.32-3.34)	0.0019
≥ 4	0.59 (0.34-1.03)	0.0646	0.80 (0.42-1.55)	0.5105
Total disease count by quartile	**n=3,692**	**0.0158***		**0.0294***
1-3	1.0		1.0	
4-6	1.04 (0.76-1.44)	0.7960	0.88 (0.61-1.27)	0.4877
7-9	0.77 (0.52-1.14)	0.1949	0.69 (0.44-1.07)	0.0937
≥ 10	0.59 (0.39-0.88)	0.0103	0.49 (0.30-0.81)	0.0049
Mode of arrival to ED	**n=3,870**	**0.0441***		**0.1321**
Self – private transportation	1.0		1.0	
Ambulance	1.36 (1.01-1.81)	0.0398	1.27 (0.93-1.76)	0.1321
Frequent ED user	**n=3,871**	**0.7038**		**0.2403**
No	1.0		1.0	
Yes	0.93 (0.63-1.36)	0.7061	0.78 (0.51-1.18)	0.2403

Year of ED visit	**n=3,871**	**0.5149**		**0.8145**
2013	1.0		1.0	
2012	1.03 (0.73-1.45)	0.8685	1.03 (0.71-1.50)	0.8586
2011	0.91 (0.63-1.31)	0.5996	0.95 (0.64-1.41)	0.8021
2010	0.79 (0.54-1.15)	0.2233	0.82 (0.57-1.29)	0.4484
	n=3,621	**0.3829**		**0.6667**
Total costs[d]	1.07 (0.92-1.26)	0.3834	1.04 (0.88-1.23)	0.6667
PIM ordered in ED	**n=2,940**	**0.5914**	-	
No	1.0			
Yes	1.09(0.80-1.49)	0.6338		
Discharge disposition	**n=3,869**	**0.6134**	-	
Home or self-care	1.0			
Left AMA	0.76 (0.41-1.41)	0.3849		
Left before clinical evaluation	1.18 (0.51-2.73)	0.7058		

[a] * = p <0.05 statistically significant.
[b] n= 3,394 due to missing responses, exclusion of unknown race and ethnicity category, admit mode by helicopter, and discharge disposition categories of other facility/nursing home and expired.
[c] Likelihood ratio for probability of address in zip code 23220 $X^2 = 79.13$, $p<0.0001$
[d] Costs are log transformed

Emergent ED visits

There were a total of 77 emergent ED visits in zip code 23220. Due to small sample size (cell size <5), unknown race and ethnicity, arrival by helicopter, and a discharge disposition of other facility/nursing home and left before clinical evaluation were considered missing for emergent ED visits. Race of Asian was collapsed into the other category. Additionally, due to small sample size, many of the levels of the independent variables were missing. The variable total ED cost was log transformed due to skewed distribution. The variables PIM ordered in the ED and PIM number (linear combination of variables) and total diagnosis count and total diagnosis count by quartiles (VIFs 3-9) were collinear. The variables total disease count number and PIM ordered in the ED and PIM number were removed and multicollinearity was reassessed. The resulting VIFs for the reduced model ranged from 1.0-1.8, indicating multicollinearity was not a concern. Eigenvalues and condition indexes were also examined and indications of multicollinearity were not found in the intercept adjusted reduced model. As the PIM ordered in the ED variable had

25% missing observations, it was not included in full adjusted logistic regression model. The variables health care hot spot residence, ethnicity, and payment source were not stable in the unadjusted or full logistic regression model and were not included. A total of 75 observations had a |R-student| >2, ranging from 3.0-4.1, indicative of an outlier. These outliers were examined in the data and no obvious error entry or cause was observed. The outliers were kept in the analyzed data set.[110,111]

The results of chi-square tests (categorical variables) and t-tests (continuous variables) for emergent ED visits by zip code 23220 are summarized in Table 55. Discharge disposition and health care hot spot residence were statistically different by zip code 23220. A higher proportion of zip code 23220 ED visits had a discharge disposition of left AMA (8% vs. 2%). As above, the health care hot spot is located in the 23220 zip code; thus, all emergent ED visits were in the zip code 23220 (yes) category. Age, gender, race, ethnicity, payment source, CCI score, total disease count, PIM ordered in the ED, mode of arrival, frequent ED user, year of ED visit, and total ED costs were not statistically different by zip code 23220.

Table 54. Demographics and ED visit characteristics by zip code 23220 for emergent ED visits VCUHS ED, 2010-2013				
Variables	**Emergent ED Visits (n=1,179) Mean (SD), Range or n (%)**	**Zip code 23220, NO (n=1,102) Mean (SD), Range or n (%)**	**Zip code 23220,YES (n=77) Mean (SD), Range or n (%)**	**Chi-square or t-test between zip code 23220 groups p-value**
Age (years)	73.0 (6.9), 65-99	72.9 (6.8), 65-99	73.3 (7.8), 65-95	**0.6789**
Age by quartile	**n=1,179**	**n=1, 102**	**n=77**	**0.2395**
65-67 years	295 (25.0)	274 (24.9)	21 (27.3)	
68-71 years	316 (26.8)	294 (26.7)	22 (28.6)	
72-78 years	311 (26.4)	298 (27.0)	13 (16.9)	
≥ 79 years	257 (21.8)	236 (21.4)	21 (27.3)	
Gender	**n=1,179**	**n=1, 102**	**n=77**	**0.2438**
Female	717 (60.8)	675 (61.3)	42 (54.6)	
Male	462 (39.2)	427 (38.8)	35 (45.5)	
Race[a]	**n=1,178**	**n=1,101**	**n=77**	**0.1382**
Black or African-American	895 (76.0)	830 (75.4)	65 (84.4)	
White	242 (20.5)	233 (21.2)	9 (11.7)	
Other	41 (3.5)	38 (3.5)	3 (3.9)	
Ethnicity[b]	**n=1,152**	**n=1,077**	**n=75**	**0.2011**
Not Hispanic-Latino-Spanish origin	1,129 (98.0)	1,054 (97.9)	75 (100.0)	
Hispanic-Latino-Spanish origin	23 (2.0)	23 (2.1)	-	
Payment source	**n=1,179**	**n=1,102**	**n=77**	**0.2876**
Medicare	1,012 (85.8)	942 (85.5)	70 (90.9)	
Other	62 (5.3)	58 (5.3)	4 (5.2)	
Virginia Coordinated Care	28 (2.4)	28 (2.5)	-	
Medicare, Other	23 (2.0)	23 (2.1)	-	
Medicaid	20 (1.7)	17 (1.5)	3 (3.9)	
Indigent	13 (1.1)	13 (1.2)	-	
Medicare , Medicaid	12 (1.0)	12 (1.1)	-	
Self-pay	9 (0.8)	9 (0.8)	-	
Charlson Comorbidity Index Score	**n=1,135**	**n=1,1062**	**n=73**	**0.4236**
0	288 (25.4)	263 (24.8)	25 (34.3)	
1	386 (34.0)	363 (34.2)	23 (31.5)	
2	171 (15.1)	163 (15.4)	8 (11.0)	
3	118 (10.4)	110 (10.4)	8 (11.0)	
≥ 4	172 (15.2)	163 (15.4)	9 (12.3)	
Total disease count by quartile	**n=1,135**	**n=1,062**	**n=73**	**0.5832**
1-3	259 (22.8)	241 (22.7)	18 (24.7)	
4-6	375 (33.0)	354 (33.3)	21 (28.8)	
7-9	234 (20.6)	215 (20.2)	19 (26.0)	
≥ 10	267 (23.5)	252 (23.7)	15 (20.6)	
Total disease count	7.0 (4.7), 1-27	7.0 (4.7), 1-27	6.6 (4.1) 1-19	**0.4393**

PIM ordered in ED	**n=887**	**n=829**	**n=58**	**0.1295**
Yes	278 (31.3)	265 (32.0)	13 (22.4)	
No	609 (68.7)	564 (68.0)	45 (77.6)	
Number of PIM ordered in ED	**n=887**	**n=829**	**n=58**	**0.1673**
0	609 (68.7)	564 (68.0)	45 (77.6)	
1	236 (26.6)	224 (27.0)	12 (20.7)	
2	36 (4.1)	36 (4.3)	-	
3-5	6 (0.7)	5 (0.6)	1 (1.7)	
Mode of arrival to ED[c]	**n=1,177**	**n=1,100**	**n=77**	**0.6682**
Self – private transportation	715 (60.8)	670 (60.9)	45 (58.4)	
Ambulance	462 (39.3)	430 (39.1)	32 (41.6)	
Discharge disposition[d]	**n=1,173**	**n=1,096**	**n=77**	**0.0138***
Home or self-care	1,103 (94.0)	1,034 (94.3)	69 (89.6)	
Expired	39 (3.3)	37 (3.4)	2 (2.6)	
Left AMA	31 (2.6)	25 (2.3)	6 (7.8)	
Frequent ED user	193 (16.4)	183 (16.6)	10 (13.0)	**0.4066**
Year of ED visit	**n=1,179**	**n=1,102**	**n=77**	**0.9029**
2010	306 (26.0)	284 (25.8)	22 (28.6)	
2011	295 (25.0)	275 (25.0)	20 (26.0)	
2012	281 (23.8)	263 (23.9)	18 (23.4)	
2013	297 (25.2)	280 (25.4)	17 (22.1)	
Hot spot residence	19 (1.6)	-	19 (24.7)	**<0.0001**
Total costs ($)[e]	$947 ($709), $0-$11,901	$949 ($716), $0-$11,901	$905 ($612), $92-$2,450	**0.5980**

[a] Due to small sample size, unknown race (n=1), was considered missing. Race of Asian (n=4) was collapsed into the other category.
[b] Due to small sample size, unknown ethnicity (n=1) was considered missing.
[c] Due to small sample size, arrival to ED by helicopter (n=0) was missing.
[d] Due to small sample size, discharge disposition of other facility/nursing home (n=3) and left before clinical evaluation (n=3) were considered missing.
[e] Total costs rounded to nearest dollar
* $p < 0.05$

The results of the bivariate logistic regression analysis (unadjusted odds ratio (OR), 95% confidence interval (CI)) and multivariable logistic regression analysis (adjusted AOR, 95% CI) are summarized in Table 56. None of the variables (age, gender, race, CCI score, total disease count category, mode of ED arrival, discharge disposition, frequent ED user, total costs, or PIM ordered in the ED) had a significant unadjusted relationship with zip code 23220. In the full logistic regression model, only race had a statistically significant relationship with zip code 23220 in the presence of all the other variables. ED visits by white patients were 62% less likely

to be from zip code 23220 (AOR 0.38, 95% CI: 0.18-0.83). Age, gender, CCI score, total disease count category, mode of ED arrival, discharge disposition, frequent ED use, and total costs were not significantly related to zip code 23220 in the presence of all other variables.

Table 55. Demographics and ED visit characteristics predictors of zip code 23220 in emergent ED visits: VCUHS ED, 2010-2013				
Variables	**Unadjusted Odds Ratio (OR) (95%CI)**	**p-value[a]**	**Adjusted OR (95% CI)[b,c] (n=1,124)**	**p-value[a]**
Age by quartile	**n=1,179**	**0.2111**		**0.2017**
65-67 years	1.0		1.0	
68-71 years	0.98 (0.53-1.82)	0.9397	0.98 (0.51-1.87)	0.9415
72-78 years	0.57 (0.28-1.16)	0.1202	0.51 (0.24-1.08)	0.0784
≥ 79 years	1.16 (0.62-2.18)	0.6420	1.09 (0.56-2.13)	0.7915
Gender	**n=1,179**	**0.2473**		**0.1408**
Female	1.0		1.0	
Male	1.32 (0.83-2.10)	0.2449	1.46 (0.88-2.43)	0.1408
Race	**n=1,178**	**0.1067**		**0.0476***
Black or African-American	1.0		1.0	
White	0.49 (0.24-1.01)	0.0517	0.38 (0.18-0.83)	0.0143
Other	1.01 (0.30-3.35)	0.9895	1.07 (0.31-3.71)	0.9122
CCI Score[d]	**n=1,135**	**0.4390**		**0.2744**
0	1.0		1.0	
1	0.67 (0.37-1.20)	0.1764	0.63 (0.34-1.19)	0.1546
2	0.52 (0.23-1.17)	0.1140	0.43 (0.18-1.04)	0.0603
3	0.77 (0.34-1.75)	0.5255	0.64 (0.26-1.56)	0.3244
≥ 4	0.58 (0.27-1.28)	0.1758	0.43 (0.17-1.09)	0.0746
Total disease count by quartile	**n=1,135**	**0.5942**		**0.4690**
1-3	1.0		1.0	
4-6	0.79 (0.41-1.52)	0.4877	0.99 (0.49-1.98)	0.9766
7-9	1.18 (0.61-2.31)	0.6221	1.63 (0.78-3.39)	0.1914
≥ 10	0.80 (0.39-1.62)	0.5296	1.28 (0.55-2.96)	0.5685
Mode of arrival to ED	**n=1, 177**	**0.6691**		**0.4922**
Self – private transportation	1.0		1.0	
Ambulance	1.11 (0.69 -1.77)	0.6683	1.20 (0.72-1.99)	0.4922
Discharge disposition	**n=1,173**	**0.0516**		**0.0833**
Home or self-care	1.0		1.0	
Left AMA	3.60 (1.43-9.06)	0.0066	3.22 (1.15-9.06)	0.0264
Expired	0.81 (0.19-3.43)	0.7748	0.96 (0.21-4.39)	0.9553
Frequent ED user	**n=1,179**	**0.3934**		**0.2356**
No	1.0		1.0	
Yes	0.75 (0.38-1.48)	0.4085	0.65 (0.32-1.33)	0.2356
Year of ED visit	**n=1, 179**	**0.9015**		**0.9688**
2013	1.0		1.0	
2012	1.13 (0.57-2.23)	0.7314	0.98 (0.47-2.03)	0.9571
2011	1.20 (0.61-2.34)	0.5962	1.07 (0.53-2.15)	0.8464
2010	1.28 (0.66-2.45)	0.4654	1.15 (0.58-2.28)	0.6953
	n=1,176	**0.3307**		**0.5449**
Total costs[e]	0.86 (0.63-1.17)	0.3283	0.90 (0.64-1.26)	0.5449
PIM ordered in ED	**n=887**	**0.1187**		
No	1.0		-	
Yes	0.62 (0.33-1.16)	0.1328		

[a] * = p <0.05 statistically significant.

[b] n=1,124 due to missing responses, missing unknown race, unknown ethnicity, arrival to ED via helicopter, discharge disposition of other facility/nursing home and left before clinical evaluation

[c] Likelihood ratio for probability of address in zip code 23220 $X^2 = 25.36$, df=21, p=0.2317

[d] CCI = Charlson Comorbidity Index

[e] Costs are log transformed

Summary

In summary, the proposed hypotheses for aim 3B, the variable used to test the relationship with zip code 23220, and the results are listed in Table 57 and 58. Table 57 provides a summary of the analysis for non-emergent ED visits and Table 58 provides a summary of the analysis for emergent ED visits.

Table 56. Summary of hypothesis testing results for non-emergent ED visits: VCUHS ED, 2010-2013

Hypotheses tested	Variable from data	Results
HA1: Patients who live in zip code 23220 with a non-emergent ED visit will be older than those who do not live in zip code 23220.	• Age by quartile	This hypothesis was rejected. *Age* had a non-significant association (p=0.20) with zip code 23220, while controlling for all other variables in the model.
HA2: Patients who live in zip code 23220 with a non-emergent ED visit will have higher CCI scores than those who do not live in zip code 23220.	• CCI score	This hypothesis was accepted. *A CCI score of 3* compared to 0 was significantly associated with zip code 23220 (AOR 2.10 (95% CI: 1.32-3.34), while controlling for all other variables in the model.
HA3: Patients who live in zip code 23220 with a non-emergent ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.	• Mode of arrival	This hypothesis was rejected. *Arriving to the ED via ambulance* compared to self/private transportation had a non-significant association (p=0.13) with zip code 23220, while controlling for all other variables in the model.
HA4: Patients who live in zip code 23220 with a non-emergent ED visit will have higher total costs than those who do not live in zip code 23220.	• Total costs	This hypothesis was rejected. *Total costs* had a non-significant association (p=0.67) with zip code 23220, while controlling for all other variables in the model.
HA5: Patients who live in zip code 23220 with a non-emergent ED visit will have a higher disease count than those who do not live in zip code 23220.	• Total disease count by quartile	This hypothesis was rejected due to being the opposite direction, but was statistically significant. *A total disease count of ≥ 10* compared to 1-3 was significantly associated with zip code 23220 (AOR 0.49 (95%CI: 0.30-0.81), while controlling for all other variables in the model.

H06: There will be no effect of gender, race, ethnicity, payment source, discharge disposition, PIM ordered in the ED, health care hot spot address, frequent ED use, and year of ED visit in a non-emergent ED visit by patients who live in zip code 23220.	• Gender • Race • Ethnicity • Payment source • Frequent ED user • Year of ED visit • PIM ordered in ED • Discharge disposition • Health care hot spot address	This hypothesis was rejected. *White race* was significantly associated with zip code 23220 compared to African American race (AOR 0.33 (95% CI: 0.19-0.57), while controlling for all other variables in the model. *Gender* (p=0.31), *Ethnicity* (p=0.93), *payment source* (p=0.12), *frequent ED user* (p=0.24), and *year of ED visit* (p=0.81) had a non-significant association with zip code 23220, while controlling for all other variables in the model. *PIM ordered in the ED, discharge disposition, and health care hot spot address were not included in the final multivariable model.*

Table 57. Summary of hypothesis testing results for emergent ED visits: VCUHS ED, 2010-2013

Hypotheses tested	Variable from data	Results
HA7: Patients who live in zip code 23220 with an emergent ED visit will be older than those who do not live in zip code 23220.	• Age by quartile	This hypothesis was rejected. *Age* had a non-significant association (p=0.20) with zip code 23220, while controlling for all other variables in the model.
HA8: Patients who live in zip code 23220 with an emergent ED visit will have higher CCI scores than those who do not live in zip code 23220.	• CCI score	This hypothesis was rejected. *CCI score* had a non-significant association (p=0.27) with zip code 23220, while controlling for all other variables in the model.
HA9: Patients who live in zip code 23220 with an emergent ED visit will be more likely to arrive via ambulance than those who do not live in zip code 23220.	• Mode of arrival	This hypothesis was rejected. *Arriving to the ED via ambulance* compared to self/private transportation had a non-significant association (p=0.49) with zip code 23220, while controlling for all other variables in the model.

HA10: Patients who live in zip code 23220 with an emergent ED visit will have higher total costs than those who do not live in zip code 23220.	• Total costs	This hypothesis was rejected. *Total costs* had a non-significant association (p=0.54) with zip code 23220, while controlling for all other variables in the model.
HA11: Patients who live in zip code 23220 with an emergent ED visit will have a higher disease count than those who do not live in zip code 23220.	• Total disease count by quartile	This hypothesis was rejected. *Total disease count* had a non-significant association (p=0.47) with zip code 23220, while controlling for all other variables in the model.
H012: There will be no effect of gender, race, ethnicity, payment source, discharge disposition, PIM ordered in the ED, health care hot spot address, frequent ED use, and year of ED visit in a non-emergent ED visit by patients who live in zip code 23220.	• Gender • Race • Ethnicity • Payment source • Frequent ED user • Year of ED visit • PIM ordered in ED • Discharge disposition • Health care hot spot address	This hypothesis was rejected. *White race* was significantly associated with zip code 23220 compared to African American race (AOR 0.38 (95% CI: 0.18-0.83), while controlling for all other variables in the model. *Gender* (p=0.14), *discharge disposition* (p=0.08), *frequent ED user* (p=0.24), and *year of ED visit* (p=0.97) had a non-significant association with zip code 23220, while controlling for all other variables in the model. *PIM ordered in the ED, ethnicity payment source, and health care hot spot address were not included in the final multivariable model.*

3.3.3 Aim 3C

The relationship between demographics and ED visit characteristics with total costs was evaluated in this aim. Non-emergent and emergent ED visits classified by the NYU ED algorithm were included in this aim. A subgroup analysis of non-emergent and emergent ED visits from zip code 23220 was conducted. Similar to aim 3B, due to small sample size (cell size < 5), unknown race and ethnicity, admission by helicopter, and a discharge disposition of expired or other facility/nursing home were considered missing. Asian was collapsed into the other category. The variable PIM medication use was not included in the multivariable analysis due to 24% of observations with missing data (1,221 ED visits). The data was first evaluated for violations of assumptions for all ED visits and then the subgroup of zip code 23220 ED visits. The results of the data evaluation are presented by the two analyses.

The dependent cost variable was assessed for skewness, Kurtosis, normality, and heteroscedasticity in the non-emergent and emergent ED visits. The data indicated that total costs were skewed to the right (skewness: 2.71, Kurtosis: 29.61, n=5,050). Skewness is 0 in normal distributions and a Kurtosis value of >3 indicates a higher skewed peak and tails. The assumption of normality was violated (n= 5,050, Kolmogorov-Smirnov, $p<0.010$). The histogram of the cost variable also showed a non-normal distribution and the q-q plot showed five extreme outliers. The five extreme observations, with a total cost of $11,901, $5,368, $4,438, $3,859 and $2, were deleted from the data and skewness, Kurtosis, normality, and heteroscedasticity was reassessed. The skewness and Kurtosis were improved (1.30 and 1.37, respectively) but the data was still not normally distributed (n =5,045, Kolmogorov-Smirnov, $p<0.010$, histogram appearance skewed)

or homoscedastic (White test for heteroscedasticity p=0.003). Next, log transformation of the total costs was performed. There were 253 ED encounters with zero cost (5% of study sample). The appearance of the cost histogram was improved. However, the normality and equal error variance assumptions were still violated (n=4,792, Kolmogorov-Smirnov, p<0.010 and White test for heteroscedasticity p<0.0001). This was accounted for in the final generalized linear model with a gamma distribution and log link. GLM does not require normal distribution of the cost data and can correct for heteroscedasticity (unequal error variance).[106-108]

Additionally, a multiple regression model of the non-emergent and emergent ED visits was assessed for multicollinearity. No correlation between the independent variables was above the 0.80 cut off for collinearity. The Variance Inflation Factors (VIFs) were between 1.0 and 2.7, indicating multicollinearity was not a concern in this model. Eigenvalues and condition indexes were also examined and indications of multicollinearity were not found in the intercept adjusted model. In the model with costs log-transformed, a total of 22 observations (0.5% of the sample) had a |R-student| >2, ranging from 2.0 to 3.0, indicative of an outlier. These outliers were examined in the data and no obvious error entry or cause was observed. Therefore, the outliers were kept in the analyzed data set. [110,111]

Next, the ED visits from zip code 23220 were split from the all non-emergent and emergent ED visits. There were only 321 ED visits from zip code 23220 in this data set. The dependent cost variable was assessed for skewness, Kurtosis, normality, and heteroscedasticity as above. The total costs were skewed to the right (skewness: 1.2, Kurtosis: 1.3) and assumption of normality was violated (n= 321, Kolmogorov-Smirnov, p<0.010). The histogram of the cost variable also

showed a non-normal distribution. The results of the White test for heteroscedasticity were non-significant (p=0.9870) indicating that they null hypothesis of no heterogeneity failed to be rejected. Next, log transformation of the total costs was performed. There were 16 ED encounters with zero cost (5% of zip code 23220 ED visits). The appearance of the cost histogram was improved. However, the normality assumption was still violated (n=305, Kolmogorov-Smirnov, p<0.010). The results of the White test for heteroscedasticity remained non-significant (p=0.5321). Even though error variance was less of a concern in the subgroup of ED visits from zip code 23220, the normality assumptions were still violated. To address this, the final generalized linear model used a gamma distribution and log link. GLM does not require normal distribution of the cost data.[106-108]

Similarly, a multiple regression model of the subgroup of 23220 ED visits was assessed for multicollinearity. No correlation between the independent variables was above the 0.80 cut off for collinearity. The Variance Inflation Factors (VIFs) were between 1.1 and 2.5, indicating multicollinearity was not a concern in this model. Eigenvalues and condition indexes were also examined and indications of multicollinearity were not found in the intercept adjusted model. In the model with costs log-transformed, there were no observations with a |R-student| >2, indicative of an outlier.

A total of 5,045 ED visits were included in this analysis of which a total of 3,870 ED visits were non-emergent and 1,175 were emergent ED visits. There were a total of 321 non-emergent and emergent ED visits from zip code 23220. The results are presented below by the two analyses:

All non-emergent and emergent ED visits and non-emergent and emergent ED visits from zip code 23220.

All non-emergent and emergent ED visits

The results of the bivariate analysis (ANOVA) of the demographic and ED visit characteristics with mean total ED costs are summarized in Table 59. Total ED costs increased with age. The age ≥ 79 years category had a higher mean total ED cost ($694) than ED visits by 65-67, 68-71, or 72-78 years category ($607, $614, $645, respectively). White race had a higher mean total ED cost ($685) than African-American ($625) or other ($641) race categories. Likewise, ambulance arrival to the ED vs. self-private transportation ($807 vs. $577), not a frequent ED user vs. frequent user ($644 vs. $599), and emergent ED vs. non-emergent visit type ($928 vs. $549) had higher mean total ED costs than their counterpart. ED visits with a discharge disposition to home or self-care had a higher mean total ED cost ($666) than those ED visits with a discharge disposition of left AMA ($210) or left before clinical evaluation ($58). The year 2013 had the highest mean total ED costs ($730) compared to years 2010-2012 ($566-$656). The mean total ED costs were not statistically different by gender, ethnicity, payment source, CCI score, total disease count category, zip code 23220, or health care hot spot residence.

Table 58. Bivariate analysis between demographics and ED visit characteristics and total ED costs for non-emergent and emergent ED visits (n=5,045): VCUHS ED, 2010-2013			
Variables	**n (%)**	**Total ED costs ($)[a] Mean (SD), Range**	**p-value**
Age by quartile	**n=5,045**		0.0004*
65-67 years	1,349 (26.7)	607 (577), 0-2,903	
68-71 years	1,285 (25.5)	614 (546), 0-3,236	
72-78 years	1,311 (26.0)	645 (543), 0-2,854	
≥ 79 years	1,100 (21.8)	694 (535), 0-3,341	
Gender	**n=5,045**		0.8377
Female	3,212 (63.7)	639 (543), 0-3,342	
Male	1,833 (36.3)	636 (568), 0-2,903	
Race	**n=5,040**		0.0114*
Black or African-American	3,900 (77.4)	625 (543), 0-3,326	
White	948 (18.8)	685 (578), 0-3,341	
Other	192 (3.8)	641 (596), 0-2,973	
Ethnicity	**n=4,945**		0.6952
Not Hispanic-Latino-Spanish origin	4,859 (98.3)	639 (553), 0-3,341	
Hispanic-Latino-Spanish origin	86 (1.7)	615 (543), 0-2,243	
Payment source	**n=5,045**		0.1131
Medicare	4,264 (84.5)	640 (548), 0-3,341	
Other	272 (5.4)	609 (563), 0-2,860	
Virginia Coordinated Care	129 (2.6)	633 (622), 0-2,243	
Medicare, Other	114 (2.3)	751 (617), 0-2,756	
Medicaid	92 (1.8)	579 (508), 0-2,266	
Indigent	84 (1.7)	513 (517), 0-2.215	
Medicare, Medicaid	45 (0.9)	694 (559), 0-2,095	
Self-pay	45 (0.9)	599 (613), 0-2,379	
Charlson Comorbidity Index Score	**n=4,822**		0.0775
0	1,453 (30.1)	609 (562), 0-3,341	
1	1,480 (30.7)	658 (559), 0-2,973	
2	768 (15.9)	669 (579), 0-2,903	
3	548 (11.4)	639 (525), 0-2.661	
≥ 4	573 (11.9)	636 (509), 0-3,236	
Total disease count by quartile	**n=4,822**		0.7303
1-3	1,302 (27.0)	635 (570), 0-3,341	
4-6	1,468(30.4)	633 (557), 0-2,973	
7-9	967 (20.1)	657 (549), 0-3,236	
≥ 10	1,085 (22.5)	642 (534), 0-2,821	
PIM ordered in the ED[b]	**n=3,824**		<0.0001*
Yes	1,123 (29.4)	764 (614), 0-2,903	
No	2,701 (70.6)	674 (532), 0-3,341	

Number of PIM ordered in ED[b]	**n=3,824**		<00001*
0	2,701 (70.6)	674 (532), 0-3,341	
1	933 (24.4)	771 (623), 0-2,903	
2	167 (4.4)	709 (540), 30-2,418	
3-5	23 (0.6)	865 (723), 163-2,286	
Mode of arrival to ED	**n=5,042**		<0.0001*
Self – private transportation	3,711 (73.6)	577 (535), 0-3,341	
Ambulance	1,331 (26.4)	807 (562), 0-3,236	
Discharge disposition	**n=5,004**		<0.0001*
Home or self-care	4,666 (93.2)	666 (544), 0-3,341	
Left AMA	254 (5.1)	210 (452), 0-2,244	
Left before clinical evaluation	84 (1.7)	58 (207), 0-1,161	
Frequent ED user	**n=5,045**		0.0383*
No	4,313 (85.5)	644 (556), 0-3,341	
Yes	732 (14.5)	599 (525), 0-2,553	
Year of ED visit	**n=5,045**		<0.0001*
2013	1,323 (26.2)	730 (593), 0-2,903	
2012	1,297 (25.7)	656 (562), 0-3,341	
2011	1,208 (23.9)	589 (526), 0-2,787	
2010	1,217 (24.1)	566 (504), 0-3,236	
Zip code 23220	**n=5,045**		0.5246
No	4,724 (93.6)	636 (551), 0-3,341	
Yes	321 (6.4)	657 (568), 0-2,973	
Hot spot residence	**n=5,045**		0.3451
No	4,976 (98.6)	638 (554), 0-3,341	
Yes	69 (1.4)	575 (426), 0-2,237	
Type of ED visit	**n=5,045**		<0.0001*
Non-emergent	3,870 (76.7)	549 (502), 0-3,341	
Emergent	1,175 (23.3)	928 (607), 0-2,903	

[a] Costs rounded to nearest dollar, *p<0.05
[b] PIM = Potentially inappropriate medication

Results from the bivariate analysis (crude generalized linear model regression) and full generalized linear model regression to evaluate predictors of total ED costs for all non-emergent and emergent ED visits are provided in Table 60. Age, race, arrival mode to the ED, frequent ED user, ED visit year, NYU ED algorithm category visit type (emergent or non-emergent), PIM ordered in the ED, and PIM number ordered had a significant bivariate relationship with total ED costs. In the bivariate analyses, age ≥ 79 years had 8% higher total ED costs than age 65-67-73

years (95% CI:1.02-1.15) and frequent ED users had 7% lower total ED costs than non-frequent users (exp(β): 0.93, 95% CI: 0.87-0.99).

In the full prediction model, race, mode of arrival to the ED, year of ED visit, and NYU ED algorithm category visit type were significant predictors of total ED costs, while controlling for all other variables. ED visits by white patients had 14% higher and those in the other race category had 16% higher total ED costs than ED visits by African-American patients (White race: 95% CI: 1.07-1.21; Other race: 95% CI: 1.01-1.33). Arriving to the ED via ambulance was associated with 26% higher total ED costs than arrival by self/private transportation (95%CI: 1.20-1.32). Emergent ED visits were 60% more likely to have higher total ED costs than non-emergent visits (95% CI: 1.52-1.69). An ED visit in 2010, 2011, or 2012 was associated with lower total ED costs than an ED visit in 2013 ($\exp(\beta)_{2010}$: 0.72 (95% CI: 0.68-0.77), $\exp(\beta)_{2011}$: 0.76 (95% CI: 0.71-0.81), $\exp(\beta)_{2012}$: 0.89 (95% CI: 0.83-0.94)). Age, gender, ethnicity, payment source, CCI score, total disease count, discharge disposition, frequent ED user, zip code 23220, and health care hot spot residence were not significant predictors of total ED costs, while controlling for all other variables.

Table 59. Relationship between demographics and ED visit characteristics with total ED costs: VCUHS ED, 2010-2013										
	Crude Generalized Linear Model Regression analysis					Adjusted Generalized Linear Model Regression analysis [a]				
Parameter	**β**	**SE**	**exp(β) (95% CI)**	**Wald chi square**	**p-value**	**β**	**SE**	**exp(β) (95% CI)**	**Wald chi square**	**p-value**
Intercept						6.4369	0.0408		25025.7	**<0.0001**
Age by quartile (n=4,792)					**0.0256***					**0.2523**
65-67 years	1.0	-	1.0	-	-	1.0	-	1.0	-	-
68-71 years	-0.0017	0.0315	0.99 (0.93-1.05)	0.14	0.7103	-0.0040	0.0316	1.00 (0.94-1.06)	0.02	0.8999
72-78 years	0.0342	0.0313	1.03 (0.97-1.10)	1.19	0.2753	0.0120	0.0317	1.01 (0.95-1.08)	0.14	0.7054
≥ 79 years	0.0793	0.0325	1.08 (1.02-1.15)	5.94	0.0148	0.0568	0.0334	1.06 (0.99-1.13)	2.89	0.0892
Gender (n=4,792)					**0.9792**					**0.2847**
Female	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Male	-0.0006	0.0235	1.00 (0.95-1.05)	<0.01	0.9792	-0.0256	0.0240	0.97 (0.93-1.02)	1.14	0.2847
Race (n=4,787)					**0.0002***					**<0.0001***
Black or African-American	1.0	-	1.0	-	-	1.0	-	1.0	-	-
White	0.1169	0.0293	1.12 (1.06-1.19)	15.96	<0.0001	0.1311	0.0303	1.14 (1.07-1.21)	18.72	<0.0001
Other	0.0910	0.0610	1.10 (0.97-1.23)	2.22	0.1358	0.1466	0.0717	1.16 (1.01-1.33)	4.18	0.0409
Ethnicity (n=4,696)					**0.9660**					**0.4211**
Not Hispanic-Latino-Spanish origin	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Hispanic-Latino-Spanish origin	-0.0038	0.0890	1.00 (0.84-1.19)	<0.01	0.9660	-0.0785	0.0976	0.92 (0.76-1.12)	0.65	0.4211
Payment source (n=4,792)					**0.1130**					**0.0759**
Medicare	1.0		1.0			1.0	-	1.0	-	-
Other	-0.0350	0.0505	0.97 (0.87-1.07)	0.48	0.4883	-0.0824	0.0516	0.92 (0.83-1.02)	2.55	0.1102
Self-pay	-0.0460	0.1214	0.96 (0.75-1.21)	0.14	0.7048	0.0192	0.1335	1.02 (0.78-1.32)	0.02	0.8855
Virginia Coordinated Care	0.0121	0.0725	1.01 (0.88-1.17)	0.03	0.8670	0.0026	0.0768	1.00 (0.86-1.17)	<0.01	0.9729
Medicare, Other	0.1649	0.0763	1.18 (1.02-1.37)	4.67	0.0306	0.0873	0.0785	1.09 (0.94-1.27)	1.24	0.2659
Medicaid	-0.1050	0.0843	0.90 (0.76-1.06)	1.55	0.2130	-0.1568	0.0836	0.85 (0.73-1.01)	3.52	0.0609
Indigent	-0.1830	0.0900	0.83 (0.70-0.99)	4.13	0.0420	-0.1904	0.0916	0.83 (0.69-0.99)	4.32	0.0376
Medicare, Medicaid	0.0764	0.1200	1.08 (0.85-1.37)	0.41	0.5243	0.1328	0.1205	1.14 (0.90-1.45)	1.21	0.2704

CCI Score [b] (n=4,586)					**0.2034**					**0.3828**
0	1.0	-	1.0	-	-	1.0	-	1.0	-	-
1	0.0520	0.0297	1.05 (0.99-1.12)	3.06	0.0804	0.0272	0.0300	1.03 (0.97-1.09)	0.82	0.3641
2	0.0767	0.0359	1.08 (1.006-1.16)	4.55	0.0329	0.0653	0.0370	1.07 (0.99-1.15)	3.12	0.0776
3	0.0254	0.0403	1.03 (0.95-1.11)	0.40	0.5289	0.0272	0.0418	1.03 (0.95-1.12)	0.42	0.5155
≥ 4	0.0125	0.0395	1.01 (0.94-1.09)	0.10	0.7518	-0.0059	0.0441	0.99 (0.91-1.08)	0.02	0.8942
Total disease count by quartile (n=4,586)					**0.9578**					**0.5833**
1-3	1.0	-	1.0	-	-	1.0	-	1.0	-	-
4-6	-0.0117	0.0307	0.99 (0.93-1.05)	0.15	0.7031	-0.0310	0.0359	0.97 (0.91-1.03)	0.97	0.3259
7-9	0.0056	0.0340	1.01 (0.94-1.08)	0.03	0.8686	0.0108	0.0375	1.01 (0.94-1.08)	0.09	0.7641
≥ 10	-0.0057	0.0331	0.99 (0.93-1.06)	0.03	0.8632	-0.0054	0.0257	0.99 (0.92-1.07)	0.02	0.8848
Mode of arrival to ED (n=4,789)					**<0.0001***					**<0.0001***
Self – private transportation	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Ambulance	0.2750	0.0250	1.32 (1.25-1.38)	120.61	<0.0001	0.2288	0.0257	1.26 (1.20-1.32)	79.09	<0.0001
Discharge disposition (n=4,751)					**0.2088**					**0.2538**
Home or self-care	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Left AMA	0.0269	0.0894	1.03 (0.86-1.22)	0.09	0.7633	-0.0339	0.0899	0.97 (0.81-1.15)	0.14	0.7057
Left before clinical evaluation	-0.4120	0.2365	0.66 (0.42-1.05)	3.04	0.0815	-0.3652	0.2260	0.69 (0.45-1.08)	2.61	0.1061
Frequent ED user (n=4,792)					**0.0171***					**0.2484**
No	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Yes	-0.0765	0.0321	0.93 (0.87-0.99)	5.69	0.0171	-0.0370	0.0321	0.96 (0.90-1.03)	1.33	0.2484
Year of ED visit (n=4,792)					**<0.0001***					**<0.0001***
2013	1.0	-	1.0	-	-	1.0	-	1.0	-	-
2012	-0.1069	0.0313	0.90 (0.85-0.96)	11.68	0.0006	-0.1204	0.0311	0.89 (0.83-0.94)	15.00	0.0001
2011	-0.2257	0.0318	0.80 (0.75-0.85)	50.44	<0.0001	-0.2766	0.0316	0.76 (0.71-0.81)	76.62	<0.0001
2010	-0.2834	0.0316	0.75 (0.71-0.80)	80.60	<0.0001	-0.3233	0.0319	0.72 (0.68-0.77)	102.46	<0.0001
Zip code 23220 (n=4,792)					**0.5034**					**0.4452**
No	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Yes	0.0310	0.0463	1.03 (0.94-1.13)	0.45	0.5034	0.0393	0.0515	1.04 (0.94-1.15)	0.58	0.4452
Hot spot address (n=4,792)					**0.1388**					**0.2109**
No	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Yes	-0.1416	0.0956	0.87 (0.72-1.05)	2.19	0.1388	-0.1335	0.1067	0.88 (0.71-1.08)	1.57	0.2109

Type of ED visit (n=4,792)					**<0.0001***					**<0.0001***
Non-emergent	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Emergent	0.4599	0.0256	1.58 (1.51-1.67)	323.99	<0.0001	0.4710	0.0265	1.60 (1.52-1.69)	315.77	<0.0001
PIM ordered in the ED[c] (n=3,819)					**<0.0001***	-	-	-	-	-
No	1.0	-	1.0	-	-	-	-	-	-	-
Yes	0.1257	0.0272	1.13 (1.08-1.20)	21.43	<0.0001	-	-	-	-	-
Number of PIM ordered in ED[c] (n=3,819)					**<0.0001***	-	-	-	-	-
0	1.0	-	1.0	-	-	-	-	-	-	-
1	0.1358	0.0290	1.15 (1.08-1.21)	21.85	<0.0001	-	-	-	-	-
2	0.0486	0.0609	1.05 (0.93-1.18)	0.64	0.4248	-	-	-	-	-
3-5	0.2488	0.1600	1.28 (0.94-1.75)	2.42	0.1199	-	-	-	-	-

[a] n=4,464 were included in the final model after exclusion of missing responses, zero costs, five extreme cost outliers, unknown race and ethnicity category, admit mode by helicopter, and discharge disposition categories of other facility/nursing home and expired. Scaled Pearson X^2 =5,077.32, df =4,432, p<0.001

[b] CCI = Charlson Comorbidity Index

[b] PIM = Potentially inappropriate medication

*p<0.05

Non-emergent and emergent ED visits for zip code 23220

A subgroup analysis was conducted for ED visits from zip code 23220. There were a total of 321 non-emergent and emergent ED visits from zip code 23220. The results of the bivariate analysis (ANOVA) of the demographic and ED visit characteristics with mean total ED costs for zip code 23220 are summarized in Table 61.

Total ED costs increased with age. The age ≥ 79 years category had a higher mean total ED cost ($876) than ED visits by 65-67, 68-71, or 72-78 years category ($615, $515, $614, respectively). White race had a higher mean total ED cost ($948) than African-American ($624) or other ($768) race categories. Likewise, ambulance arrival to the ED vs. self-private transportation ($841 vs. $573) and emergent ED vs. non-emergent visit type ($905 vs. $578) had higher mean total ED costs than their counterpart. ED visits with a discharge disposition to home or self-care had a mean total ED cost than those with a discharge disposition of left AMA ($681 vs. $345). The mean total ED costs varied by payment source, with VCC payment type having the lowest mean total ED costs ($147). The year 2012 had the highest mean total ED costs ($736) compared to years 2010, 2011, and 2013 ($519, $610, and $730, respectively) The mean total ED costs were not statistically different by gender, ethnicity, CCI score, total disease count category, PIM ordered in the ED or PIM number ordered, or health care hot spot residence.

Table 60. Bivariate analysis between demographics and ED visit characteristics and total ED costs for non-emergent and emergent ED visits, zip code 23220 (n=321): VCUHS ED, 2010-2013			
Variables	**n (%)**	**Total ED costs ($)[a] Mean (SD), Range**	**p-value**
Age by quartile	**n=321**		0.0004*
65-67 years	96 (29.9)	615 (575), 0-2,450	
68-71 years	77 (24.0)	515 (485), 0-2,237	
72-78 years	67 (20.9)	614 (517), 0-2,244	
≥ 79 years	81 (25.2)	876 (620), 0-2,973	
Gender	**n=321**		0.5307
Female	207 (64.5)	642 (543), 0-2,973	
Male	114 (35.5)	683 (614), 0-2,681	
Race	**n=321**		0.0148*
Black or African-American	280 (87.2)	624 (538), 0-2,246	
White	26 (8.1)	948 (661), 242-2,681	
Other	15 (4.7)	768 (809), 0-2,973	
Ethnicity	**n=317**		0.2991
Not Hispanic-Latino-Spanish origin	314 (99.1)	651 (568), 0-2,973	
Hispanic-Latino-Spanish origin	3 (1.0)	995 (840), 242-1,902	
Payment source[b]	**n=317**		0.0163*
Medicare	277 (87.4)	696 (582), 0-2,973	
Other	16 (5.1)	359 (438), 0-1,918	
Medicaid	12 (3.8)	406 (273), 102-1,050	
Medicare, Other	7 (2.2)	599 (561), 111-1,429	
Virginia Coordinated Care	5 (1.6)	147 (138), 0-302	
Charlson Comorbidity Index Score	**n=310**		0.8303
0	101 (32.6)	641 (608), 0-2,681	
1	106 (34.2)	717 (598), 0-2,973	
2	30 (9.7)	639 (513), 0-2,027	
3	48 (15.5)	614 (474), 95-1,902	
≥ 4	25 (8.1)	643 (611), 0-2,097	
Total disease count by quartile	**n=310**		0.9297
1-3	94 (30.3)	687 (549), 0-2,681	
4-6	104 (33.6)	646 (628), 0-2,973	
7-9	61 (19.7)	637 (493),106-2,027	
≥ 10	51 (16.5)	684 (612), 0-2,097	
PIM ordered in the ED[b]	**n=255**		0.5187
Yes	73 (28.6)	738 (626), 106-2,681	
No	182 (71.4)	687 (535), 94-2,973	
Number of PIM ordered in ED[b]	**n=255**		0.1251
0	182 (71.4)	687 (535), 94-2,973	
1	57 (22.4)	815 (672), 106-2,681	
2	12 (4.7)	513 (324), 147-1,015	
3-5	4 (1.6)	311 (198), 163-586	

Mode of arrival to ED	**n=321**		<0.0001*
Self – private transportation	221 (68.9)	573 (559), 0-2,973	
Ambulance	100 (31.2)	841 (549), 0-2,681	
Discharge disposition[c]	**n=313**		0.0164
Home or self-care	296 (94.6)	681 (555), 94-2,973	
Left AMA	17 (5.4)	345 (618), 0-2,244	
Frequent ED user	**n=321**		0.7112
No	279 (86.9)	652 (564), 0-2,973	
Yes	42 (13.1)	687 (604), 0-2,246	
Year of ED visit	**n=321**		0.0494*
2013	86 (26.8)	730 (592), 0-2,681	
2012	88 (27.4)	736 (635), 0-2,973	
2011	76 (23.7)	610 (562), 0-2,244	
2010	71 (22.1)	519 (421), 0-2,097	
Hot spot residence	**n=321**		0.1804
No	252 (78.5)	679 (601), 0-2,973	
Yes	69 (21.5)	575 (426), 0-2,237	
Type of ED visit	**n=321**		<0.0001*
Non-emergent	244 (76.0)	578 (532), 0-2,973	
Emergent	77 (24.0)	905 (612), 92-2,450	

a Costs rounded to nearest dollar. *p<0.05
b Due to small sample size, Payment source of Indigent (n=1), Medicare, Medicaid (n=1) Self-pay (n=0) considered missing
c Discharge disposition of left before clinical evaluation (n=6) considered missing due to all having zero costs

Results from the bivariate analysis (crude generalized linear model regression) and full generalized linear model regression to evaluate predictors of total ED costs for non-emergent and emergent ED visits from zip code 23220 are provided in Table 62. Age, race, payment source, arrival mode to the ED, year of ED visit, and NYU ED algorithm category visit type (emergent or non-emergent) had a significant bivariate relationship with total ED costs. In the bivariate analyses, age ≥ 79 years had 35% higher total ED costs (95% CI:1.07-1.71) than age 65-67 years, and white race was associated with 44% higher total ED costs than African-American race (95%CI: 1.05-1.98). Those with Medicaid, VCC, or other payment source had 44-66% lower total ED costs than Medicare in the unadjusted analysis.

In the full prediction model, age, payment source, mode of arrival to the ED, year of ED visit, and NYU ED algorithm category visit type were significant predictors of total ED costs, while controlling for all other variables. ED visits by older adults age ≥ 79 years had 34% higher total ED costs than ED visits by those aged 65-67 years (exp(β): 1.34, 95% CI: 1.05-1.70). A payment source of other or Medicaid was associated with lower total ED costs than Medicare (Other exp(β): 0.65, 95% CI: 0.43-0.98, Medicaid exp(β): 0.55, 95% CI: 0.35-0.86). Arrival to the ED via ambulance had 38% higher total ED costs than self-private transportation arrival mode (95% CI: 1.15-1.66). An ED visit in 2010 was associated with lower total ED costs than an ED visit in 2013 ($\exp(\beta)_{2010}$: 0.68 (95% CI: 0.53-0.86). Emergent ED visits were 78% more likely to have higher total ED costs than non-emergent visits (95% CI: 1.43-2.21). Gender, race, ethnicity, CCI score, total disease count, discharge disposition, frequent ED user, and health care hot spot residence were not significant predictors of total ED costs in zip code 23220, while controlling for all other variables.

Table 61. Relationship between demographics and ED visit characteristics with total ED costs for zip code 23220: VCUHS ED, 2010-2013										
	Crude Generalized Linear Model Regression analysis					Adjusted Generalized Linear Model Regression analysis[a]				
Parameter	**β**	**SE**	**exp(β) (95% CI)**	**Wald chi square**	**p-value**	**β**	**SE**	**exp(β) (95% CI)**	**Wald chi square**	**p-value**
Intercept						6.2873	0.1447		1887.6	**<0.0001**
Age by quartile (n=305)					**0.0018***					**0.0118***
65-67 years	1.0	-	1.0		-	1.0	-	1.0	-	-
68-71 years	-0.1748	0.1226	0.84 (0.66-1.07)	2.03	0.1539	-0.1283	0.1272	0.88 (0.69-1.13)	1.02	0.3132
72-78 years	-0.0038	0.1274	1.00 (0.78-1.28)	<0.01	0.9763	0.1123	0.1358	1.12 (0.86-1.46)	0.68	0.4083
≥ 79 years	0.3015	0.1192	1.35 (1.07-1.71)	6.40	0.0114	0.2891	0.1221	1.34 (1.05-1.70)	5.61	0.0179
Gender (n=305)					**0.3115**					**0.7515**
Female	1.0	-	1.0		-	1.0	-	1.0	-	-
Male	0.0962	0.0951	1.10 (0.91-1.33)	1.02	0.3115	0.0322	0.1016	1.03 (0.85-1.26)	0.10	0.7515
Race (n=305)					**0.0358***					**0.1118**
Black or African-American	1.0	-	1.0		-	1.0	-	1.0	-	-
White	0.3679	0.1611	1.44 (1.05-1.98)	5.22	0.0224	0.3508	0.1736	1.42 (1.01-2.00)	4.08	0.0433
Other	0.2995	0.2227	1.35 (0.87-2.09)	1.81	0.1786	0.1630	0.2451	1.18 (0.73-1.90)	0.44	0.5059
Ethnicity (n=301)					**0.4195**					**0.1994**
Not Hispanic-Latino-Spanish origin	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Hispanic-Latino-Spanish origin	0.3718	0.4605	1.45 (0.59-3.58)	0.65	0.4195	0.5979	0.4659	1.82 (0.73-4.53)	1.65	0.1994
Payment source (n=301)					**0.0003***					**0.0112***
Medicare	1.0		1.0			1.0	-	1.0	-	-
Other	-0.6453	0.2055	0.52 (0.35-0.78)	9.86	0.0017	-0.4287	0.2101	0.65 (0.43-0.98)	4.16	0.0413
Virginia Coordinated Care	-1.0935	0.4496	0.34 (0.14-0.81)	5.92	0.0150	-0.7982	0.4373	0.45 (0.19-1.07)	3.33	0.0680
Medicare, Other	-0.1973	0.2965	0.82 (0.46-1.47)	0.44	0.5058	-0.0605	0.2833	0.94 (0.54-1.64)	0.05	0.8308
Medicaid	-0.5871	0.2286	0.56 (0.36-0.88)	6.60	0.0102	-0.5990	0.2279	0.55 (0.35-0.86)	6.91	0.0086
CCI Score [b] (n=295)					**0.7794**					**0.8106**
0	1.0	-	1.0	-	-	1.0	-	1.0	-	-
1	0.0257	0.1140	1.03 (0.82-1.28)	0.05	0.8215	0.0432	0.1222	1.04 (0.82-1.33)	0.12	0.7239
2	-0.0738	0.1693	0.93 (0.67-1.29)	0.19	0.6627	0.0949	0.1749	1.10 (0.78-1.55)	0.29	0.5874
3	-0.1472	0.1416	0.86 (0.65-1.14)	1.08	0.2986	-0.1000	0.1544	0.90 (0.67-1.22)	0.42	0.5173
≥ 4	-0.0187	0.1853	0.98 (0.68-1.41)	0.01	0.9194	-0.0783	0.2135	0.92 (0.61-1.41)	0.13	0.7139

Total disease count by quartile (n=295)					**0.7166**					**0.6604**
1-3	1.0	-	1.0	-	-	1.0	-	1.0	-	-
4-6	-0.0575	0.1163	0.94 (0.75-1.19)	0.24	0.6213	-0.1363	0.1125	0.87 (0.70-1.09)	1.47	0.2256
7-9	-0.1308	0.1321	0.88 (0.68-1.14)	0.98	0.3220	-0.1303	0.1494	0.88 (0.66-1.18)	0.76	0.3830
≥ 10	0.0220	0.1433	1.02 (0.77-1.35)	0.02	0.8778	-0.0782	0.1650	0.92 (0.67-1.28)	0.22	0.6356
Arrival to ED (n=305)					**0.0007***					**0.0005***
Self – private transportation	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Ambulance	0.3225	0.0953	1.38 (1.15-1.66)	11.46	0.0007	0.3256	0.0934	1.38 (1.15-1.66)	12.15	0.0005
Discharge disposition (n=303)					**0.4921**					**0.5136**
Home or self-care	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Left AMA	0.2075	0.3021	1.23 (0.68-2.22)	0.47	0.4921	-0.2263	0.3464	0.80 (0.40-1.57)	0.43	0.5136
Frequent ED user (n=305)					**0.7126**					**0.1251**
No	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Yes	0.0495	0.1343	1.05 (0.81-1.37)	0.14	0.7126	0.2110	0.1376	1.23 (0.94-1.62)	2.35	0.1251
Year of ED visit (n=305)					**0.0030***					**<0.0001***
2013	1.0	-	1.0	-	-	1.0	-	1.0	-	-
2012	0.0309	0.1222	1.03 (0.82-1.31)	0.06	0.8004	0.1460	0.1222	1.16 (0.91-1.47)	1.43	0.2322
2011	-0.1987	0.1255	0.82 (0.64-1.05)	2.51	0.1133	-0.2079	0.1249	0.81 (0.64-1.04)	2.77	0.0959
2010	-0.3869	0.1269	0.68 (0.53-0.87)	9.30	0.0023	-0.3919	0.1231	0.68 (0.53-0.86)	10.13	0.0015
Hot spot residence (n=305)					**0.0501**					**0.6322**
No	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Yes	-0.2123	0.1084	0.81 (0.65-1.00)	3.84	0.0501	0.0594	0.1242	1.06 (0.83-1.35)	0.23	0.6322
Type of ED visit (n=305)					**0.0002***					**<0.0001***
Non-emergent	1.0	-	1.0	-	-	1.0	-	1.0	-	-
Emergent	0.3807	0.1023	1.46 (1.20-1.79)	13.85	0.0002	0.5755	0.1101	1.78 (1.43-2.21)	27.34	<0.0001
PIM ordered in ED[c] (n=255)					**0.5085**	-	-	-	-	-
No	1.0	-	1.0	-	-	-	-	-	-	-
Yes	0.0707	0.1069	1.07 (0.87-1.32)	0.44	0.5085	-	-	-	-	-
Number of PIM ordered in ED[c] (n=255)					**0.0310***	-	-	-	-	-
0	1.0	-	1.0	-	-	-	-	-	-	-
1	0.1703	0.1157	1.19 (0.95-1.49)	2.17	0.1411	-	-	-	-	-
2	-0.2931	0.2272	0.75 (0.48-1.16)	1.66	0.1971	-	-	-	-	-
3-5	-0.7920	0.3853	0.45 (0.21-0.96)	4.22	0.0399	-	-	-	-	-

[a] n=287 were included in the final model after exclusion of missing responses, zero costs, five extreme cost outliers, unknown race and ethnicity category, admit mode by helicopter, payment source categories of indigent and Medicare, Medicaid, and discharge disposition categories of before clinical evaluation, other facility/nursing home, and expired. Scaled Pearson X^2 =304.32, df =260, p=0.03

[b] CCI = Charlson Comorbidity Index, [c] PIM = Potentially inappropriate medication *p<0.05

Summary

In summary, the proposed hypotheses for aim 3C -all non-emergent and emergent ED visits, the variable used to test the relationship, and the results are listed in Table 63.

Table 62. Summary of aim 3C hypothesis testing. all non-emergent and emergent ED visits: VCUHS ED, 2010-2013

Hypotheses tested	Variable from data	Results
HA13: Zip code 23220 will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.	• Zip code 23220	This hypothesis was rejected. *Zip code 23220* had a non-significant association (p=0.44) with total ED costs, while controlling for all other variables in the model.
HA14: Increasing age will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.	• Age by quartile	This hypothesis was rejected. *Age* had a non-significant association (p=0.25) with total ED costs, while controlling for all other variables in the model.
HA15: Larger CCI scores will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.	• CCI score	This hypothesis was rejected. The *CCI score* had a non-significant association (p=0.38) with total ED costs, while controlling for all other variables in the model.
HA16: Arrival to the ED via ambulance will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.	• Mode of arrival	This hypothesis was accepted. *Arrival to the ED via ambulance* was significantly associated with higher total ED costs (exp(β): 1.26 (95% CI: 1.20-1.32)) than self/private transportation, while controlling for all other variables in the model.
HA17: Higher total disease count will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.	• Total disease count	This hypothesis was rejected. *Total disease count* had a non-significant association (p=0.58) with total ED costs, while controlling for all other variables in the model.

H018: There will be no effect of gender, race, ethnicity, payment source, discharge disposition, PIM ordered in the ED, health care hot spot address, frequent ED user, NYU ED algorithm category, and year of ED visit on total ED costs.	• Gender • Race • Ethnicity • Payment source • Discharge disposition • Health care hot spot address • Frequent ED user • NYU ED algorithm category • Year of Visit • PIM use	This hypothesis was rejected. *White or other race category* was significantly associated with higher total ED costs compared to African American race, while controlling for all other variables in the model. *Race* African-American: Reference group White exp(β): 1.14 (95% CI: 1.07-1.21) Other exp(β): 1.16 (95% CI: 1.01-1.33) *Year of ED visit* (2010-2012) was significantly associated with lower total ED costs compared to ED visits in 2013, while controlling for all other variables in the model. *Year of ED visit* 2013: Reference group 2012 exp(β): 0.89 (95% CI: 0.83-0.94) 2011 exp(β): 0.76 (95% CI: 0.71-0.81) 2010 exp(β): 0.72 (95% CI: 0.68-0.77) *Gender* (p=0.28), *ethnicity* (p=0.42), *payment source* (p=0.08), *discharge disposition* (p=0.25), and health care hot spot address (p=0.21) had a non-significant association with total ED costs, while controlling for all other variables in the model. *PIM use not included due to large number of missing values.*

Additionally, the proposed hypotheses for non-emergent and emergent ED visits in zip code 23220, the variable used to test the relationship, and the results are summarized in Table 64.

Table 63. Summary of aim 3C hypothesis testing, non-emergent and emergent ED visits from zip code 23220: VCUHS ED, 2010-2013

Hypotheses tested	Variable from data	Results
HA19: Increasing age will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.	• Age by quartile	This hypothesis was accepted. *Age ≥ 79 years* was significantly associated with higher total ED costs than age 65-67 years (exp(β) 1.34, 95% CI: 1.05-1.70), while controlling for all other variables in the model.
HA20: Larger CCI scores will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.	• CCI score	This hypothesis was rejected. The *CCI score* had a non-significant association (p=0.81) with total ED costs, while controlling for all other variables in the model.
HA21: Arrival to the ED via ambulance will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.	• Mode of arrival	This hypothesis was accepted. *Arrival to the ED via ambulance* was significantly associated with higher total ED costs (exp(β): 1.38 (95% CI: 1.15-1.66)) than self/private transportation, while controlling for all other variables in the model.
HA22: Higher total disease count will be a significant positive predictor of higher total ED billing costs, while controlling for all other variables in the model.	• Total disease count	This hypothesis was rejected. *Total disease count* had a non-significant association (p=0.66) with total ED costs, while controlling for all other variables in the model.

H023: There will be no effect of gender, race, ethnicity, payment source, discharge disposition, PIM ordered in the ED, health care hot spot address, frequent ED user, NYU ED algorithm category (non-emergent or emergent), and year of ED visit on total ED costs.	• Gender • Race • Ethnicity • Payment source • Discharge disposition • Health care hot spot address • Frequent ED user • NYU ED algorithm category • Year of Visit • PIM use	This hypothesis was rejected. *Emergent ED visit type* was significantly associated with higher total ED costs (exp(β): 1.78 (95% CI: 1.43-2.21)) than non-emergent ED visit type, while controlling for all other variables in the model. *Payment source* – Medicaid and Other payment source categories were significantly associated with lower total ED costs than Medicare, while controlling for all other variables in the model. Medicaid exp(β): 0.55 (95% CI: 0.35-0.86) Other exp(β): 0.65 (95% CI: 0.43-0.98) *Years of ED visit* 2010 was significantly associated with lower total ED costs compared to ED visits in 2013, while controlling for all other variables in the model. 2010 exp(β): 0.68 (95% CI: 0.53-0.86) *Race* (p=0.11), *gender* (p=0.75), *ethnicity* (p=0.20), *discharge disposition* (p=0.51), *frequent ED user* (p=0.13), and *health care hot spot address* (p=0.63) had a non-significant association with total ED costs, while controlling for all other variables in the model. *PIM use not included due to large number of missing values.*

Chapter 4: Discussion

4.1 Discussion Overview

The discussion of this study's results begins with a comparison of predisposing, enabling, and need factors and use of health services across the study aims. Next, study results are discussed by aims 1A and 1B, aim 1C, and aim 3. Finally, an overall discussion of study results is provided.

4.1.1 Comparison of Predisposing, Enabling, and Need Factors and Use of Health Services Variables across Study Aims

The theoretical framework that guided the selection of variables for this study was the Gelberg-Andersen Behavioral Model for Vulnerable Populations (Gelberg-Andersen model). The Gelberg-Andersen model incorporates predisposing, enabling, and need factors, from both traditional and vulnerable domains, to predict health behaviors (e.g. use of health services) and health outcomes.[84] In the following four sections, the descriptive results of the predisposing, enabling, and need factors along with use of health services across study aims are compared for the health care hot spot residents. Thus, the comparisons are provided by the three sources of data analyzed in this study: resident interviews (aims 1A and 1B, n=14), an existing data set from RHWP participant charts (aim 1C, n=97), and 2010-2013 VCUHS ED visit information from the low-income, subsidized housing apartment building (aim 3, n=104). As this low-income, subsidized housing apartment building was identified as a health care hot spot due to high rates

of ambulance use in 2012, this section adds to the literature characterizing health care hot spots. A comparison of study results to the available literature about older adults residing in public or subsidized housing is also presented.

4.1.1.1 Predisposing Factors

The traditional predisposing factors included were age, gender, race, ethnicity, education level, and marital status. The mean age was 65.7 years (SD 12.3) for interview participants, 71.5 years (SD 9.3) for RHWP participants, and 71.7 years (SD 5.8) for VCUHS ED visits from the health care hot spot. Other studies conducted in older adults residing in public housing report a median age of 66 years.[53,58] Similarly, the majority of older adults residing in New York City Housing Authority (NYCHA) buildings were 65-75 years.[56] Overall, the age of older adults in this study was similar to other studies of older adults residing in public housing.

The majority were female across all data sources in this study (57% interview participants, 58% RHWP participants, and 53% VCUHS ED visits from the health care hot spot). A similar percentage (58%) of public housing residents in Rochester, NY were women.[53,58] In contrast, 71% of NYCHA residents were women.[56] In an analysis of the Health and Retirement Study data, the majority (77%) that reported ever living in public housing were women.[52] Likewise, the majority were African-American in this study (79% interview participants, 61% RHWP participants, and 84% of VCUHS ED visits from the health care hot spot). Only one VCUHS ED visit was by a patient of Hispanic-Latino-Spanish ethnicity. This majority compares to other studies reporting 74-78% of public housing residents being African-American race.[53,55,58]

Whereas, 40% of NYCHA older adult public housing residents were African-American and 44% were of Hispanic ethnicity. [56] Demographic information from the 2010 Census indicated that the city of Richmond was 52% female and 51% African-American, which was similar to this study's demographics.[112] In summary, the percentage of female residents and distribution of race varied across studies. The NYCHA buildings were most different than this study with higher percentages of women and Hispanic residents and lower percentages of African-American residents.

The majority of interview participants (57%) and RHWP participants (65%) had an education level of 12 or more years. Education level was not available in the VCUHS ED data. Other studies report a similar percentage (53-57%) of participants completing high school.[55,58] Marital status was collected in the resident interviews only; most participants were either divorced (50%) or never married (43%). Marital status was not reported in the reviewed literature. However, 92% of Rochester older adults lived alone and 53% of NYCHA residents reported a single-person household.[56,62] The vulnerable predisposing factor, health literacy, was only collected in resident interviews. Nine of the fourteen participants scored at an 8th grade or lower reading level on the REALM-SF indicating health literacy may be a concern in residents. The REALM-SF measures reading comprehension from a medical perspective. [113] The Agency for Healthcare Research and Quality suggests to use the REALM-SF scores to determine appropriate level of patient education materials. [113] For instance, a REALM-SF score of a third grade or below reading level indicates that the participant will not be able to read most low-literacy materials, will need repeated oral instructions, and will need education materials comprised of pictures or videos. [113] A participant with a REALM-SF score of fourth to sixth grade reading level will need

low-literacy materials and may not be able to read prescription labels. [113] A participant with a REALM-SF score of a seventh to eighth grade reading level will have difficulty with most education materials. [113] Thus, designing education materials and delivery to match the health literacy levels of RHWP participants may improve their understanding of health-related information. Overall, education level in this health care hot spot was similar across studies of public housing residents as well as most residents living alone. The additional reporting of health literacy in interview participants helps add to the literature about older adults residing in public housing. Further exploration of the level of health literacy in RHWP participants and building residents and its role in care transition problems is warranted.

4.1.1.2 Enabling Factors

The traditional enabling factors included were health insurance, regular PCP, yearly income, anyone to help with care, social contact to help with care, and years of residence in the low-income, subsidized housing apartment building. Health insurance was the only traditional enabling factor available in all three study data sources. Medicare was the most common health insurance overall (43% interview participants, 47% of RHWP participants, and 76% of VCUHS ED visits from the health care hot spot). Similarly to interview and RHWP participants, 42% of older adults residing in NYCHA buildings had only Medicare insurance.[57] The percentage of dual-eligible Medicare-Medicaid patients differed by data source (36% of interview participants and 41% of RHWP participants were dual-eligible compared to 3% of VCUHS ED visits from the health care hot spot). A higher percentage (55%) of NYCHA public housing residents were dual-eligible.[57] The low percentage of health care hot spot VCUHS ED visits by dual-eligible residents may be indicative of misclassification bias due to limitations in coding the primary

health plan name or that dual-eligible residents used a different local ED. Using more than one data source to examine ED use (e.g. other local ED or an all payer claims database) may help to fully characterize the demographics of the residents that visit the ED.

The majority of interview participants (93%) and RHWP participants at intake (87%) reported having a regular PCP. This is similar to the 89% of NYCHA residents who reported having a personal doctor or health care provider.[57] Only 21% of interview participants and RHWP participants had someone to help with their care. In the RHWP participants, a sibling or the participants' child was the most common reported social contact to help with care. In contrast, 70% of NYCHA residents reported that they had a friend, relative, or neighbor to assist them for a few days if needed.[57] This difference may be related to the structure of the question. It is unknown if interview participants or RHWP participants would have answered yes to the same prompt as NYCHA residents. Older adults' social networks help the older adult to access resources and provide social support when needed.[114,115] Life events, such as retirement, loss of a loved one, and health can have an effect on both the older adult's social network size and composition.[114] One study indicated that African-American older adults with low socioeconomic status lost more confidants than whites and college educated older adults.[115] Although more confidants were lost (primarily due to death) in the African-American older adults, they also added more confidants to their social network over time than white older adults.[115] The role of social networks and their change over time in this building's residents warrants further study, especially in relation to the decision making process to use the ED.

Income level was obtained in the resident interviews only. The majority (58%) of interview participants reported a yearly income of $10-19,999. Approximately half of NYCHA older adult public housing residents reported an income level of less than 100% of the federal poverty level ($10,830 in 2009).[56] The most common categories for years of building residence in RHWP participants were: less than 1 year (22%), 1-5 years (38%), and 6-10 years (22%). Whereas, 27% of older adults in NYCHA reported living in NYCHA housing for 40 years or longer.[56] It is unknown if the NYCHA residents lived in the same housing building or if this contributed to NYCHA's residents feeling that they had someone to help them with their care for a few days if needed. It is also unknown whether this study's residents lived in public or subsidized housing before living at this apartment building.

The vulnerable enabling factors included were transportation source, use of assistive devices, ability to drive, other method of transportation, phone access, and activities of daily living. None of the enabling factors were available in the VCUHS ED data set. Only 36% of interview participants reported having a regular source of transportation and only 23% of RHWP participants reported being able to drive. About 20% of NYCHA residents used special transportation services such as services provided by senior centers or transportation services covered by Medicaid.[57] The most common method of other transportation in RHWP participants was using the bus (54%). Use of assistive devices was only available in the RHWP existing data set and was not reported for other residents of public housing. The majority of RHWP participants (51%) reported using an assistive device (e.g. cane or walker). Access to a phone was only measured in resident interviews and was not reported in other studies. The majority of interview participants (93%) reported having a cell phone and 21% had a land line telephone.

The ADL score was available for about one-third of RHWP participants in the existing data set. In those that had an ADL score, about 79% were independent in the activities of daily living. Similarly, 71% of NYCHA residents were independent in their ADLs.[56] It was also observed that the number of ADL deficiencies increased with the number of chronic conditions in NYCHA residents.[56] More information about deficiencies in ADLs in RHWP participants and building residents is needed to create a complete picture of functional status and to evaluate if interventions are needed.

4.1.1.3 Need Factors

Traditional need factors included were number of chronic conditions, CCI score, type of chronic condition, number of medications, and PIM ordered in the ED. The traditional need factor varied by data source. The mean number of chronic conditions was 3.7 (SD 2.3) for interview participants and 6.1 (SD 4.3) for RHWP participants. For RHWP participants, the mean number of chronic conditions was calculated from information collected from the intake form. The intake form prompted the participant to answer yes or no to a list of conditions. Whereas in the resident interviews, the participant was asked about his or her number of chronic conditions and this is subject to recall bias. The mean total disease count was 5.8 (SD 4.2) for VCUHS ED visits from this health care hot spot. A CCI score was calculated for VCUHS ED visits from the health care hot spot residence. Most health care hot spot ED visits had a CCI score of 0 (47%), 1 (18%), or ≥ 4 (16%). About one third of the VCUHS ED visits from this health care hot spot had a CCI diagnostic category of myocardial infarction or diabetes. The majority of RHWP participants had a past medical history of hypertension (85%), visual impairment (74%), arthritis (68%), or high cholesterol (56%) at their intake visit. In addition, approximately 46% of RHWP participants had

a past medical history of diabetes. The prevalence of these conditions in older adults residing in public housing were: hypertension (75-76%),[52,54,56] arthritis (61-79%),[52,54,56] diabetes (33-37%),[52,54,56] and high cholesterol (59%). [54,56] In NYCHA residents, 79% had two or more chronic conditions.[56] About 59% of NYCHA residents had diabetes, hypertension, high cholesterol, arthritis, and osteoporosis. [57] The mean number of daily medications in interview participants was 8.3 (SD 2.3). Only 28% of VCUHS ED visits from this health care hot spot had a PIM ordered in the ED. These medication use variables were not reported in the reviewed studies. In summary, a higher proportion of RHWP participants reported hypertension and diabetes at their intake visit than other older adult public housing studies. Studies have shown that older adults may be at risk for adverse outcomes after an ED visit to fragmented care and multiple chronic conditions.[6,7] The high percentage of health care hot spot residents with multiple chronic conditions may relate to a potential need for chronic disease state management and medication management in this population.

The vulnerable need factors included were number and type of mental health conditions, substance abuse history, amount of weekly alcohol use, and type of illicit drug use. These variables were not available in the VCUHS ED visit data set (i.e. no health care hot spot ED visits were categorized as mental health-related, alcohol-related, or drug-related by the NYU ED algorithm).The majority of interview participants (71%) and RHWP participants at baseline (68%) did not report having a mental health condition. In the RHWP participants who reported having a mental health condition at baseline, 43% had depression, 13% had bipolar disorder, and 12% had schizophrenia. Other studies have shown 14-19% prevalence of depression with another 16% of older adult residents at risk for depression.[56,58] One study identified that 54% of

older adults in public housing with a treatment need for anxiety or depression were not receiving treatment. [58] This could indicate a need to screen for depression to identify residents that need treatment.

Substance abuse and alcohol use were measured in interview and RHWP participants. Twenty-one percent of interview participants reported a substance abuse history and 24% of RHWP participants reported using alcohol. In comparison, about 42% of older adults residing in four public housing buildings for older adults had a history of substance abuse.[53] Likewise, another study indicated that 44% of all older adult residents in public housing used alcohol and 23% had problem alcohol drinking behavior.[55] In the existing data set, 20% of RHWP participants with amount of alcohol used per week completed were above the recommended use level for older adults. The prevalence of substance abuse and alcohol use were lower for interview and RHWP participants than other studies. However, interview and RHWP participants may not have wanted to disclose their history and missing data is a concern for RHWP participant variables. Alcohol use is a concern in this population due to the potential of an alcohol-drug interaction leading to an adverse event.[116] A better understanding about the level of alcohol use by residents is needed to evaluate potential interventions.

4.1.1.4 Use of Health Services

The health services use variables included in this study were ED visits, RHWP use, PCP visit, hospitalization, and ambulance use. All interview participants reported visiting their PCP in the last year with a mean number of PCP visits of 6.2 (SD 6.5). The majority of interview

participants (64%) participate in the RHWP. The mean number of RHWP visits by RHWP participants was 11.5 (SD 8.7). Over one-third of interview participants (36%) were hospitalized in the past year, whereas the majority of RHWP participants (67%) were not hospitalized in the six months prior to using RHWP services. The most common reason for last hospitalization in RHWP participants at baseline was surgery.

The mean number of ED visits in the last year by interview participants was 2.8 (SD 5.0). Reasons for visiting the ED in interview participants were categorized as fall, not feeling good, pain, infection, and medication-related, heart-related, or catheter-related. Similarly, the most common ED visit reasons for RHWP participants at baseline were a fall or a urinary tract infection. The most common VCUHS ED visit primary diagnoses from this health care hot spot were chest pain or respiratory abnormality. Pain, falls, and infection appear to be similar reasons for ED use across this study's three data sources. The majority (79%) of interview participants arrived to the ED via ambulance compared to only 37% of VCUHS ED visits from this health care hot spot. In older adults residing in NYCHA public housing, about 11% used the ED for regular care.[57] In summary, study results indicate that older adults in this study had access to health care services (e.g. PCP or RHWP visits). However, overall there is limited information with regards to health services use in older adults residing in public housing.

4.1.2 Aims 1A and 1B

The qualitative thematic analysis results of semi-structured interviews with the low-income, subsidized housing apartment building residents using the ED in the past 30 days are discussed in this section. Fourteen residents participated in the interviews. This section begins with a discussion of the reasons identified for ED use and overall themes related to ED use identified in this study. Next, overall themes related to transitions of care based upon Coleman's Care Transition Intervention[83] are discussed.

4.1.2.1 ED Use

Many of this study's reasons categorized for ED use are similar to other older adult ED use studies. Pain resulted from a variety of sources in the interview participants: urinary tract pain, leg or ankle pain, pain related to a spider bite, and chest pain related to a fall or heart attack/shortness of breath. These results were similar to an analysis of 2001-2009 National Hospital Ambulatory Medical Care Survey (NHAMCS) which indicated that chest pain, shortness of breath, abdominal pain and back pain were the most common reasons for an ED visit in older adults.[2] A secondary analysis of Medicare Current Beneficiary Survey (MCBS) data indicated that infection, such as a urinary tract infection, pneumonia, and bronchitis, were ED prevalent discharge diagnoses for older adults.[17] Likewise, two participants in this study visited the ED due to an infection- pneumonia and urinary tract infection. General weakness, veritigo[2], syncope, [2,117] malaise and fatigue[117] were common reasons for ED use in older adults which are similar to this study's reasons categorized as not feeling good. National estimates indicate that about 14% of ED visits in older adults were related to an unintentional fall[4]; falls

were categorized as a reason for ED use in this study. One interview participant visited the ED due to a medication adverse event (allergic reaction). In 2007-2009, the national yearly estimate for older adults' ED visits related to adverse medication events was 265,802 ED visits per year.[118] Due to the high number of ED visits related to medication adverse events, more information is needed about their occurrence in this health care hot spot. This may be an area for additional intervention by RHWP providers. Additionally, more information is needed about other reasons for ED use in all residents to help tailor educational programs about appropriate use of the ED.

High use of ambulance services for transport to the ED was identified as an overall theme regarding ED use. The decision making process to use the ambulance for transport to the ED ranged from autonomous (participant made the decision to call) to relinquishing the control of the decision making process. Likewise, the timeline to decide to use the ED fell into two categories in this study. One theme was the timely use of ED services to address an emergent issue. The other theme was a wait-and-see and self-care approach until deciding the problem was urgent. If the problem was addressed in a more timely manner, the interview participant may not have needed to go to the ED. For example, one participant had ankle pain that progressively worsened over the course of a week until he or she was unable to walk on it. At this point he/she independently made the decision to go to the ED via ambulance. A similar decision making process was described in a qualitative study in older adult veterans, which examined veterans' decision making process for using the ED along with the role of social support networks and illness burden in the decision. They found that veterans who used the ED more than three times per year with a low risk of social isolation and low illness burden decided to use the ED on their

own. Conversely, veterans with a high illness burden and low risk for social isolation had assistance deciding to use the ED or someone told them they had to go. In veterans with high risk of social isolation, attempts at self-care for their problem were made before deciding to go the ED regardless of low or high illness burden. Many in the isolated group reported that they made the decision to go to the ED on their own. However, if a social support network member knew about their problem, the isolated veteran fully relinquished decision making control.[119] Next exploratory steps for research include investigating the role of social contacts and/or building residents and the individual's illness burden in this health care hot spot. This will help in fully understanding the decision making process used by residents who choose to use ambulance services for transportation to the ED.

Another overall theme identified was the lack of communication with a health care provider prior to ED visit. Most participants did not communicate with a health care provider before going to the ED. Similar to another study, even though over 90% of the participants reported having a PCP only 36% contacted their PCP before going to the ED.[48] In those that did not contact their PCP, main reasons for not contacting them were lack of access (e.g. did not have phone number, night hours) and emergent ED reason (e.g. no time to wait, called 911). [48] Future research could explore if participants know who to call and patient-specific reasons for not communicating with a health care provider prior to using the ED. This is also a concern in that half of the interview participants also had a history of going to the ED for the same problem, indicating a potential need for better care and communication outside of the ED.

The lack of communication with the participants PCP prior to ED use also relates to the decision making process for using ED or ambulance services described above. In this study, only two of the interview participants communicated with a health care provider before deciding to use the ED. The process of shared decision making warrants further study. Shared decision making is when the "health care provider and a patient work together to make a health care decision that is best for the patient."[120] The Agency for Healthcare Research and Quality recommends the five step SHARE approach to shared decision making: 1) Seek your patient's participation, 2) Help your patient explore and compare treatment options, 3) Assess your patient's preferences, 4) Reach a decision with your patient, and 5) Evaluate your patient's decision. [120] Health literacy can make it harder for patients to participate in shared decision making and clear communication is key to success.[121] Examples of strategies to help with communication include: speaking slowly, using a caring voice and avoiding medical jargon, presenting information in an understandable format for the patient, and using the teach-back method. [121] One study examined the decision making process for adults who use the ED for primary care needs. Results from the study indicated that either participants had no knowledge of alternative primary care options or knew of alternatives but decided to use the ED for a variety of reasons. Examples of reasons for using the ED for a primary care treatable condition included: being told to by a health care professional, access barriers to their regular source of care (e.g. after hours), feeling their condition was an emergency that needed ED care, transportation barriers to other primary care alternatives, perceived racial issues with a primary care alternative, and consideration of the cost of going to a PCP compared to an ED.[122] These reasons could be explored in future studies in participants did that not contact a health care provider before going to the ED when he or she had their problem for more than a day and or when the problem could have been treated in a primary

care setting. Additionally, more research is needed to see if better outpatient management or patient communication with their health care provider could prevent non-emergent ED use in this population.

The last overall theme resulting from the interviews was that most interview participants had their problems resolved by going to the ED. However, two interview participants did not have their problem resolved. In these cases, a perception of staff incompetency and perception of staff not addressing their concerns were identified as a theme. Although not a prevalent theme in these interviews, it still warrants concern. One study conducted interviews with patients who were high utilizers of health care services. The results indicated that there often was a difficult relationship with the health care system and negative interactions with health care providers, including lack of trust and perceived disrespect, dismissal, and discrimination because of race or sex.[123] More investigation is needed into negative experiences in the ED to identify if these themes are more widespread.

4.1.2.2 Care Transition from ED to home

The second area of interview questions addressed transition of care problems from ED to home, guided by the four pillars of the Coleman's Care Transition Intervention (CTI).[83] These pillars include medication management, provision of a personal health record, timely follow-up care, and knowing warning signs and symptoms of a worsening condition.[83] These pillars are recommended as part of a successful care transition. The overall themes related to transitions of care in the interview participants, grouped by the four pillars of the CTI, are discussed in this section.

Medication Management

Overall themes related to medication management were delay in medication receipt after discharge, lack of a current medication list, lack of education on use of a current medication list, and low use of medication reminder systems. Delayed receipt of medications is a concern after an ED visit due to the potential for adverse outcomes. Three out of the five participants who did not receive their medication on the same day as discharge relied on a friend or family member to pick up their medication. Similar problems were observed in a study of medication use after discharge from an inner city hospital where approximately 38% of patients reporting problems visiting their pharmacy and only 40% filled their prescriptions on the day of discharge.[124] Transportation services to the pharmacy may help with obtaining medication after discharge. In addition, some participants were discharged after their usual pharmacy was closed. Most participants in this study reported using a local community pharmacy for filling their prescriptions. Working with these local pharmacies to help provide discharge medications is a potential solution. At the time of this study, only one of the interview participants used the delivery services provided by a local pharmacy working with RHWP providers. Education at ED discharge about nearby 24 hour pharmacies may help participants receive their medication on the same day as discharge while transportation is available. Additionally, another method to help with timely receipt of medications may be providing the patient with medications at discharge. Many of the participants took a high number of daily medications. This corresponds to results of a study from the National Social life, Health and Aging project in over 3,000 community dwelling older adults. The study results indicated that 29% of older adults used 5 or more daily prescription medications.[125]

Few participants indicated use of medication reminder systems in this study. This may be an area for provision of a medication reminder system to residents; however, medication reminder systems need to be tailored to patient needs. For instance, one participant could not open a pill box container due to arthritis in his or her hands. Another participant had designed his or her own system and they felt highly confident in its use. Additionally, assessing the cognition of the older adult to accurately fill their pill box is suggested before such a medication reminder system is employed. One study indicated that the Mini-Cog assessment for cognitive impairment and the Medi-Cog correlates with the ability to accurately fill a pill box.[126] The Medi-Cog combines the use of the Mini-Cog cognitive impairment screening with a medication transfer screen (MTS). [126] The MTS uses a paper-based screening tool to assess the ability to comprehend four prescription instructions and fill a mock pillbox diagram. [126] The Medi-Cog had the highest correlation for accurate pillbox fill in the study. [126] A potential solution for older adults who are not able to fill their own pill box is for a health care provider or caregiver to fill the pill box instead. Additionally, telemedicine medication reminder systems, such as a smartphone with a medication adherence app (m-health) and an electronic pillbox with reminders (telehealth) were feasibility tested in older adults with heart failure in a clinical trial. The study participants rated the m-health intervention higher, but both groups had comparable medication adherence rates (over 80%). However, 93% of the older adults that participated in this trial had an education level of grade 12 or higher limiting the generalizability of the results.[127] The current study did not examine medication adherence in interview participants. However, medication non-adherence may play a significant role in the need for ED use. For example, one interview participant decided to stop taking all medications and subsequently decided to use the ED due to

not feeling good. Further examination of the association between medication nonadherence and use of the ED in this population is warranted.

Lack of a current medication list was the last overall theme identified with regards to medication management. Education is needed to inform residents about the need to have a current medication list and the need to bring their medication list with them to the ED. The National Transitions of Care Coalition (NTOCC) encourages patients to carry their medication list with them at all times. The NTOCC Personal Medicine List, is available online for patients to fill out and use. It includes prescription medications, over-the-counter medications, vitamins, and supplements. NTOCC's goal for this medication list is to help with patient medication regimen understanding and help other health care providers with the transfer of medication information and reconciliation across each transitions of care.[8] Reconciliation of prior medication regiment (e.g. home) with the current medication regimen (e.g. ED discharge) is recommended at care transitions.[6] A current medication list can provide up-to-date information for use in medication reconciliation and help prevent drug-related problems. Shared accountability between the patient and the health system is needed to make sure that a current medication list is available.

Personal Health Record

Lack of a personal health record and lack of receiving a copy of their care plan after an ED visit was a predominant theme. The goal of the personal health record (PHR) in Coleman's CTI is to help with communication of the care plan across providers and care settings. A key component of the intervention is that the patient manages his or her own PHR and shares it with their PCP and other health care providers. Besides being a tool to help with communication between

providers, one of the goals of the PHR is to encourage the patient to take an active role in their care.[128-130] Two of the interview participants expressed interest in having their own PHR. However, a careful assessment of the usefulness of a PHR in this setting is warranted. In interviews with participants in the CTI, participants indicated mixed feelings about the PHR and only about half of the participants reported that they used it. Main reasons provided by participants for not using their PHR included disinterest in managing their health and their health care providers did not see value in the patient-maintained PHR.[131] If RHWP participants were to have a PHR, it would be something that RHWP providers could monitor to ensure proper communication between health care providers and assess participants' understanding of their care plan.

Timely Follow-Up Care

Most of the interview participants were adherent with follow-up care instructions and had already had a PCP visit (or scheduled an appointment) at the time of their interview. This is not usually the case. In a study of Medicare beneficiaries, the results indicated that about half of patients that were readmitted within 30 days of hospital discharge did not visit an outpatient physician during the time period between discharge and rehospitalization, indicating gaps in follow-up care.[71] Another study indicated that 30% of PCPs were unaware of their patients' recent hospitalization. In those patients whose PCP was unaware of their hospitalization, approximately double the amount of patients experienced a post-discharge problem compared to patients whose PCP was aware of their hospitalization (67% vs. 32%).[11] More research is needed to see if this is a common theme in other residents who use the ED or if this was isolated to interview participants. Many follow-up care problems are related to the lack of accountability of

a health care provider responsible for ensuring care coordination across care transition settings and providers.[10] It is possible that having a social worker and RHWP program on site contributes to the success of the interview participants completing their follow-up care.

Knowledge of Warning Signs and Symptoms

Although several of the interview participants were knowledgeable about the warning signs and symptoms of a worsening condition, over one-third of participants were not educated on this area. This was similar to another study where participants reporting having questions after discharge related to their diagnosis.[11] Participants in the CTI reported that the transition coach provided education on warning signs and symptoms of a worsening condition which indicates a gap in education at discharge.[131] This is an area that needs to be addressed during ED discharge. Additionally, this may be an area for RHWP providers to fill a need after residents return from the ED. Successful care transition programs provided follow-up either by phone or home visit within 24 to 72 hours after discharge.[76-80,82,83] Additional care provided to residents after ED discharge, outside of the weekly scheduled clinic day, may help to improve care transitions. Better education on the warning signs and symptoms and the appropriate response to a worsening condition is needed for patients to be able to self-manage their respective conditions.

4.1.3 Aim 1C

This section begins with a discussion of reasons for ED use in comparison to the other study aims. Then, a discussion of the findings from the CCT are presented along with a discussion of a care coordination framework to measure care coordination needs.

At intake, common reasons provided for last ED visit reason by RHWP participants were falls and urinary tract infections. This aligns with reasons for ED use that were identified in the resident interviews (e.g. pain, falls, and infection). Additionally, common reasons for VCUHS ED use by the health care hot spot residents were chest pain and respiratory abnormalities. These reasons were similar to national estimates which indicated falls[4] and infection, such as a urinary tract infection, were prevalent ED discharge diagnoses for older adults.[17]

This study identified that there was a high mean number of RHWP visits per participant in the RHWP. In comparison, an analysis of information from the 2008 National Ambulatory Medical Care Survey indicated an average of 6.9 physician visits per year in older adults. [132] This supports the role of the RHWP in disease monitoring in between the participant's visit with their PCP due to the high contact with RHWP providers. Not only does having RHWP on site alleviate transportation concerns to health care appointments, it allows for more frequent monitoring of chronic disease states. One program, the Cardiovascular Health Assessment Program-Emergency Medical Services (CHAP-EMS), was identified as having similar characteristics to the RHWP.[133] CHAP-EMS is located in an older adult subsidized housing apartment building with high rates of ambulance use in Canada. [133] This paramedic-led, weekly

program included blood pressure, diabetes, and falls risk assessment, health education and promotion, goal setting and referral to community resources, identification of high risk patients, and referral of information to the participants' PCP. [133] However, the program was not interprofessional and did not involve students. CHAP-EMS's feasibility study indicated that about 25% of participants had two or more visits over a year period. [133] RHWP had a higher mean number of visits; however, the visit average was conducted after two years of program existence.

Many of the RHWP participants had care coordination needs that revolved around education or counseling and disease management or monitoring. This may indicate a lack of education being provided in other care settings. Interviews with residents using the ED revealed that none of the participants received a care plan from the ED, had a personal health record, and many did not know warning signs and symptoms of a worsening condition or who to contact. RHWP may provide a role for ensuring that participants know what to do if his or her condition worsens after a transition of care from ED to home.

Communication with the participant's PCP was a common care coordination activity performed to fulfill needs in this study. Referral management and discrepancy reconciliation was a common outcome of the RHWP. RHWP activities to achieve care coordination are supported by domains of the Agency for Healthcare Research and Quality's (AHRQ) Care Coordination Measurement Framework. This framework identified key domains and mechanisms for achieving care coordination and their relationship to coordination effects.[134] AHRQ defined these mechanisms under two categories: coordination activities and broad approaches.[134] Coordination activities

were "actions that help achieve coordination, whether employed in an improvised or systematic way".[134] Examples of coordination activities included in the framework were: interpersonal communication and information transfer among providers, facilitating transitions across settings and as care coordination needs change, assessing patient's needs and goals, monitoring and providing follow-up care, supporting self-management goals by providing patient specific education, and linking patients to community resources.[134] The goal of broad approaches was to improve the delivery of health care. [134] AHRQ defined broad approaches as being complex, incorporating several coordination activities, and facilitating or improving overall care coordination.[134] Broad approaches in this framework included integration of a health care team and a health care home (central point of care for a patient's needs) and case, disease, and medication management. [134] Future research could explore mapping RHWP care coordination activities and outcomes onto this framework as part of its program evaluation.

Preventing an adverse drug event or inappropriate medication use in RHWP participants is an area that needs to be further explored. It was identified that about 30% of VCUHS ED visits had a PIM medication ordered in the ED visit. Other studies estimate that 13-17% of older adults receive a PIM in the ED.[135-137] However, it is unknown in this study if a patient was discharged with a prescription for continued use of the PIM once returning home. A systematic process to evaluate and reconcile medication lists after an ED visit is one area that RHWP may implement in the future. Meeting patient needs, questions, and concerns was the most common outcome from the RHWP provider perspective. Evaluation of RHWP participants' satisfaction is needed to gain a full picture of RHWP outcomes.

4.1.4 Aim 3

The results of the analysis of 2010-2013 VCUHS ED electronic medical record and billing data for community-dwelling older adults are discussed in this section. This section begins with a comparison of older adult ED use of VCUHS ED to the literature. Next, the implications of the predictors of zip code 23220 and total ED costs are discussed.

This study had lower rates of ambulance use in older adults (28%) compared to national estimates indicating 38% of older adults arrived to the ED via ambulance.[4] However, the percentage of health care hot spot residents that arrived to VCUHS ED via ambulance (37%) was similar to the estimates from 2009- 2010 NHAMCS data.[4] This higher percentage of ambulance use in health care hot spot residents versus all community dwelling older adults with VCUHS ED visits helps support this building's designation as a health care hot spot due to high use of ambulance services. High use of ambulance services was also a major theme related to ED use in the resident interviews.

Other studies indicated a difference in older adults' ambulance use in non-emergent ED visits. VCUHS ED had a lower percentage of older adults arriving to the ED via ambulance for non-emergent visits (23%) compared to an analysis of ambulance transports in Medicare claims data. The Medicare claims data analysis indicated that approximately 35% of annual ambulance transports to the ED were for non-emergent conditions.[30] One difference in this study is that other payment sources besides Medicare were included. However, results from this study are supported by an analysis of 1997-2000 and 2003-2008 NHAMCS data. [24] The results indicated that those with Medicare insurance were almost twice as likely to use ambulance services for

non-urgent conditions compared to those with private insurance.[24] The role of having insurance coverage warrants further investigation in the use of ambulance services. Additionally, the Richmond Ambulance Authority offers a LifeSaver membership program to help city residents cover the cost of 911 emergent ambulance services.[138] For an annual fee ($49 per individual, $79 per family for 2016), the membership program covers insurance co-pays and deductibles for emergent ambulance transports. [138] If the resident does not have insurance, program participants receive a 20% discount on the cost of the ambulance transport. [138] In 2012, 1,251 households were enrolled in the LifeSaver membership program. [138] It is unknown how many of the VCUHS ED visits or the interview participants' ED visits were associated with a LifeSaver membership. LifeSaver membership may mitigate older adults' cost concerns when deciding to use the ambulance, especially for an older adult with transportation issues, and warrants further investigation.

The majority (62%) of VCUHS ED visits were by female patients, which was similar to other studies examining older adults ED visits.[17, 48] However, studies using data from the Medicare Claims Beneficiary Survey (MCBS)[17]and electronic medical records from an urban, academic medical center[48] had a higher mean age (77 years) of older adult patients using the ED compared to VCUHS ED (73 years). These studies included all older adults using the ED whereas this study focused on community dwelling older adults. Additionally, the majority of VCUHS ED visits were by African-American patients. In the MCBS demographics, the majority of ED visits were by white older adults (only 14% were nonwhite race). [17]

VCUHS ED's top diagnoses categorized by the NYU ED algorithm as non-emergent were: abdominal pain, no procedure/patient decision, dizziness and giddiness, respiratory abnormality, and urinary tract infection. In comparison from the validation study, abdominal pain, headache, painful respiration, neck sprain or strain, and urinary tract infection were categorized as the top non-emergent conditions in a large, integrated delivery system, Kaiser Permanente-Northern California (KP). [60] In addition, the top diagnoses categorized as emergent ED visits for VCUHS were: chest pain, syncope and collapse, shortness of breath, diabetes with complications, and palpitations. KP had chest pain, multiple open wounds, asthma, syncope and collapse and other general symptoms as its top diagnoses for emergent conditions.[60] However, the validation study included younger patients in their reporting of categorization of diagnoses for ED use. In Medicare patients using KP services, 35% of ED visits were non-emergent, 52% were emergent, and 14% were intermediate. [60] In VCUHS ED, more visits were categorized as non-emergent (75%) than emergent (23%) or intermediate (2%). However, this study included more than just Medicare as the payment source, the KP data was from 1991-2001, and a large, prepaid integrated delivery system likely has inherent differences in its patient population and use characteristics than an urban, academic medical center. Future research could include using the NYU ED algorithm to categorize older adult ED visits at other local EDs to compare percentages of non-emergent versus emergent ED visits. Additionally, exploring the number of PCPs in the area in relation to percentage of non-emergent ED visits is of interest to evaluate access to primary care services.

At this time, no other study has examined predictors of a health care hot spot zip code in ED visits. For both non-emergent and emergent VCUHS ED visits in older adults, white race was

approximately 65% less likely to be a predictor of zip code 23220 compared to African-American race. In contrast, a CCI score of 3 compared to 0 was two times more likely to be associated with zip code 23220 only for non-emergent ED visits. This indicates that higher comorbidity scores are associated with living in a health care hot spot for non-emergent ED visits but not emergent ED visits. Although not significant or not examined in this study, age ≥ 85 years, living alone, poor to very good self-rated health compared to excellent, and deficiencies in ADLs have been reported as predictors of older adult ED use.[21] Similar to the current study, a CCI score higher than zero was a predictor of older adult ED use.[21] Female gender was less likely to be associated with non-emergent ED visit in a study of Medicare patients (OR 0.82, 95%CI: 0.81-83).[60] However, predictors of non-emergent ED visits were not examined in this study (predictors of zip code 23220 were examined). Examining predictors of non-emergent and emergent ED visits in older adults is an area for future research using this data set.

Predictors of total ED costs differed in the analysis of all VCUHS ED emergent and non-emergent ED visits compared to the subgroup analysis of ED visits from zip code 23220. Not surprisingly, total ED costs were higher for emergent ED visits and ED visits where the mode of arrival was via ambulance in both groups. An interesting finding was that white race and other race were more likely to have higher costs than African-American race in zip code 23220; whereas a payment source of Other had lower costs compared to Medicare. However, this study did not support a relationship of higher costs between health care hot spot residence or frequent ED use. In contrast, past studies have shown that costs are often related to a small number of patients.[13-15] One study conducted using 2009 and 2010 Medicare data indicated that patients

with higher costs were older, male, African-American, and Medicare-Medicaid dual eligible than non-high cost patients.[5] These predictors of cost were not seen in this study. However, the small number of ED visits to VCUHS from this health care hot spot may play a role in the variables' non-significance. More research is needed into the multifaceted reasons for increased ED use and costs in this health care hot spot.

4.1.5 Overall

The predisposing, enabling, and need factors examined in this study were compared to the available literature on older adults residing in public housing. Although several similarities existed, differences were observed. This is potentially due to differences in the nature of the public housing and area demographics (e.g. large urban NYHCA versus Rochester, NY). High use of ambulance services in both the resident interviews and VCUHS ED data support characterizing this low-income, subsidized housing apartment building as a health care hot spot. Reasons for ED visits were similar across this study's aims. Reasons identified in resident interviews included pain and infection which is comparable to RHWP participants' reasons for last ED visit at baseline of falls, urinary tract infection, or auto accident. Likewise, chest pain and abdominal pain were common reasons in all community dwelling adults using VCUHS ED data. Falls may have been a common reason for VCUHS ED visit, but injuries were not categorized in the NYU ED algorithm and this was not assessed. However, about 19% of ED visits from this health care hot spot were classified as an injury, and this warrants further investigation. In the VCUHS ED, ED visits by community dwelling older adults were more often non-emergent (75%) than emergent (23%) or intermediate (2%). This warrants further study as to the use of this ED for non-emergent conditions and the potential for care to be provided in a primary care

setting. Examining predictors of zip code 23220 indicated that white race was 67% less likely compared to African-American race and a CCI score of 3 compared to 0 was two times more likely to be associated with zip code 23220; however, this was only for non-emergent ED visits. This indicates that higher comorbidity scores are associated with living in a health care hot spot for non-emergent ED visits but not emergent ED visits. An interesting finding was that white race and other race were more likely to have higher costs than African-American race in zip code 23220; whereas a payment source of other had lower costs compared to Medicare. However, this study did not support a relationship of higher costs between the variables of health care hot spot residence or frequent ED use.

4.2 Lessons Learned for Future Research

Several lessons were learned from conducting this study and will be helpful for future research projects. This section is presented by study aim. A number of challenges arose during recruitment for resident interviews. Given that one of the eligibility criteria was a recent ED visit, it was helpful to reintroduce the study to residents as time passed to generate interest and remind residents of the opportunity to volunteer if an ED visit occurred. A more formalized plan at the start of the study, with scheduled announcements, for promoting the study would have been helpful. At study onset, the IRB approval covered hanging the study information flyers on approved building signage areas. To be more active in recruitment, a subsequent IRB amendment allowed RHWP providers to invite potential participants to contact the study investigator, if interested. In retrospect, this would have been helpful from the start of the study. Another challenge with recruitment in this population was describing the study over the phone.

Many residents were hearing impaired and had difficulty hearing and/or understanding the phone conversation. The face-to-face meetings to describe the study were more successful. A script to use over the phone to describe the study may have been helpful but would not have addressed resident's hearing impairment. In addition, having the interview paperwork and study incentive on hand when at the apartment building alleviated the need to schedule a different interview time. A schedule of set days and times on site for interviews may have helped with increasing visibility of the study and participant recruitment.

Many lessons were learned with regards to research with an existing database of data collected from paper charts. It is not always an easy or a seamless transition from a paper form to a research database. The use of the data dictionary associated with the REDCap database helped with coding variables for analysis. Many of the variables needed to be recoded into aggregate variables. For example, race was a checklist variable on the REDCap electronic data entry form. Caucasian (yes/no) exported as an individual variable in the SAS dataset. Thus, all of the race categories were recoded to create one overall race variable. In addition, some variables were not structured and allowed for text entry into REDCap (e.g. method of transportation). The text variables needed to be recoded into categories for analysis. A more structured process for data abstraction (e.g. list of codes) during data collection would have alleviated this recoding. However, these codes only became apparent after review of the existing dataset. In retrospect, ideal conditions would have allowed for the incorporation of electronic documentation of RHWP visits from the start. For future studies, all efforts will be made to start with electronic documentation, including structured variables, to assist with data analysis. Additionally, a data collection protocol could help with the improvement of data collection. The data collection

protocol could include a list of codes for text variables and a data collection training program. Finally, implementing a scheduled review of missing data can provide timely feedback to improve the completeness of the data set. For example, results of this study indicated that about 30% of the race variable for RHWP participants was missing. One lesson learned or future opportunity is to retrospectively collect missing data for more complete information. A review of records at the end of each participant visit could help with the timely identification of missing data. Then, a systematic process to collect missing data could be implemented.

Another lesson learned is that practice-based research and care is not predictable. For example, a building renovation, which included the clinic space, during one of the study months led to not being able to conduct interviews during that timeframe. Also, forms that are used for data collection are also forms that are used to document clinical practice. A lesson learned is that there may be a need to change forms as processes in the clinic change or a need to adapt the form to meet the needs of the clinic. An example of this is the outcomes prevented domain on the CCT. This study indicated that about 60% of the visits did not have this variable completed. This indicates a need to assess the usefulness of this domain and possible CCT revision. As a practice-based researcher, listening to the needs and experiences of the clinical providers who incorporate research tools or data collection forms into their workflow is paramount. Efforts should be made to assess the quality of the data being recorded along with the impact on clinicians and the patient (e.g. documentation burden).

Another valuable lesson learned is the importance of clearly defining and operationalizing outcomes of interest. For example, in the proposed methods, one of the outcomes was transition

of care problems. It was not clearly defined in the research proposal how this would be measured. Clearly defining the variables *a priori* would have helped during data collection. Efforts will be made in future studies to fully operationalize all study variables during the study conceptualization phase. In addition, there was difficulty in obtaining the ambulance data to address aim 2. Lessons learned for future research include having formalized data use agreements in place as early as possible. Ideally, data use agreements would be completed in the study conceptualization phase. Additionally, having senior administration's support and buy-in to provide the data would help in case of staff turnover. In retrospect, having more than one source of data or a backup plan to address this aim would also have been helpful. A potential back-up plan or area for future research would be to use information from all local emergency departments to identify areas of high ambulance use.

It was anticipated that the data from aim 3 would be easier to analyze as it was from electronic medical records and billing data. However, even though the data was provided, it took a significant amount of time to become familiar with the data, remove duplicates, merge and transpose several files to create an analytical data set. Several variables needed to be recoded or created (e.g. recoding the payment source variable, converting SNOMED codes to ICD-9-CM codes, creating a CCI score and total disease count, identifying PIM ordered in the ED) which entailed learning several new methods of data cleaning and code. A data dictionary for each variable would have been helpful for this aim. In retrospect, it would have been most useful to have a data dictionary from the beginning. In future studies, every effort will be made to obtain the data dictionary before the proposal stage. A takeaway lesson learned is that even though the information comes from an electronic medical record it does not mean that it will be ready to

analyze. Electronic medical record data comes with its own set of problems. Budgeting the time necessary to create the analytical dataset is an important consideration in future study designs.

4.3 Study Limitations

Study limitations are addressed in this section. Selection bias is the first limitation in this study. In aims 1A and 1B (interviews with residents within 30 days of ED visit), there is potential that those who volunteered and participated in the study are different from residents that did not participate. Likewise, for aim 1C (RHWP data), there is potential that residents who voluntarily participate in the RHWP are different than residents who do not use RHWP services. Those that participate (interviews or RHWP) may be more engaged in their health care or they may be sicker than the residents who do not participate. With regards to aim 3 (VCUHS ED data), those that choose to use VCUHS ED versus other local EDs may be different. In addition, it is unknown if the patient selected VCUHS ED or if care was directed to this ED by EMS, by the patient's health insurance coverage, or because of overcrowding at other local EDs.

Social desirability bias is another potential concern in aim 1. The participants in the interviews may have wanted to please the interviewer or provide answers that they felt were more socially acceptable. Social desirability bias is also a potential concern in the existing database of information abstracted from RHWP participant charts. For example, a participant may not have wanted to reveal a high amount of alcohol use or illicit drug use during their interview or RHWP visit. Recall bias is also a concern in aim 1 as participants may not have been able to accurately remember information.

Other study limitations are small sample size for the interviews and missing data. There were only fourteen residents who participated in this study's interviews. The qualitative analysis did not reach saturation for all interview questions in this study, limiting its generalizability. Additionally, some of the constructs had the potential for high variability (e.g. individual reasons for ED use and ED experience). In the future, a longer recruitment period, recruitment at more than one health care hot spot, and increased study publicity are proposed methods to increase study enrollment. In addition, working with area EDs to help identify residents who use their ED may be another way to identify potential study participants. Many variables were identified with missing data in aim 1C (e.g. race, outcomes prevented). As aim 1C was descriptive, this study's results identified areas for improved documentation during participant visits for RHWP providers. Likewise, missing data was a concern in aim 3. There were a significant amount of ED visits without medication information limiting PIM ordered in the ED as a variable in this study (24% missing). Additionally, medications prescribed at discharge were not in this data set; limiting the analysis to only describing if a PIM ordered within the ED visit.

Another potential concern is measurement error or misclassification bias. In the VCUHS ED dataset, the ED visit problem list was a mixture of SNOMED CT and ICD-9-CM codes. A cross map was used to convert SNOMED CT codes to ICD-9-CM codes for calculating the CCI score. It is possible that not all of the SNOMED CT codes converted into ICD-9-CM codes used in the CCI calculation. Thus, the study CCI may be lower than the actual CCI. In addition, there is possibility that all patient problems were not coded with ICD-9-CM or SNOMED CT codes in the original data set (i.e. some problems are missing). The payment source variable for VCUHS

ED data was categorized from several primary health plan names. To limit misclassification bias, any primary health plan name with Medicare or Medicaid in the title was categorized as Medicare or Medicaid, respectively. It is possible that a primary health plan categorized as other may be a form of Medicare or Medicaid insurance. In all variables in the VCUHS ED dataset, the study is limited by the accuracy of the data in the electronic medical record or billing data. However, if misclassification bias occurred, it is likely to be nondifferential misclassification (i.e. the probability of being misclassified is the same for all ED visits).

The final limitation of this study is its generalizability. For aim 3, the generalizability of results is limited to other urban, academic medical centers with similar patient populations. For aim 1, the results have limited generalizability to other health care hot spot housing buildings with interprofessional programs like the RHWP, high ED or ambulance use, similar resident demographics, and urban setting.

4.4 Study Conclusions

Pain was a common reason for ED use in older adults. Care transition problems identified related to medication management and follow-up care indicate an area for targeted interventions after ED discharge. ED visits by community dwelling older adults in this study's urban, academic medical center were primarily categorized as non-emergent. Race and a higher comorbidity burden were predictors of ED use in this hot spot's zip code in non-emergent ED visits. Additional research is warranted on the decision making process to use the ED for non-emergent conditions and the potential for strategies to be developed to maximize opportunities for care in

the primary care setting. Although high rates of ambulance use were supported by this study, a larger sample size of ED visits is needed to fully characterize this low-income, subsidized housing apartment building as a health care hot spot.

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Appendices

Appendix 1. Informed Consent Documents for Aim 1 Interviews

RESEARCH SUBJECT INFORMATION AND CONSENT FORM

TITLE: Identifying Problems during Transitions of Care and Reasons for Emergency Department Utilization in Community-Dwelling Older Adults

VCU IRB NO.: HM20001261

If any information contained in this consent form is not clear, please ask the study staff to explain any information that you do not fully understand. If you like, you may take home an unsigned copy of this consent form to think about or discuss with family or friends before making your decision.

PURPOSE OF THE STUDY

The purpose of this research study is to identify problems that occur when going from the emergency department (ED) and home and reasons for ED use.

You are being asked to participate in this study because you visited an ED within the last 30 days.

DESCRIPTION OF THE STUDY AND YOUR INVOLVEMENT

If you decide to be in this research study, you will be asked to sign this consent form to participate after you have had all your questions answered and understand what will happen to you. We anticipate 20 participants in this study.

If you agree to be in this study, we will ask you to do the following things:

Participate in an interview where you will be asked questions about why you went to the ED and questions about what happened after you left the ED including any care transition problems. We will also ask you questions about your demographics and health-related information. The interview will be tape recorded so that we are sure to get your ideas, but no names will be recorded on the tape. The interview will be approximately one hour long.

We ask that you bring any paperwork or medications that you received from the ED to your interview as another source of information.

Significant new findings developed during the course of the research which may relate to your willingness to continue participation will be provided to you.

RISKS AND DISCOMFORTS

Sometimes talking about these subjects causes people to become upset. You do not have to talk about any subjects you do not want to talk about, and you may leave the interview at any time. You do not have to participate in this study. You may choose to stop participation in the study at any time without penalty. Your decision to stop participating in the study will not impact your other care, services, or benefits that you receive in the RHWP or at (name omitted).

USE AND DISCLOSURE OF PROTECTED HEALTH INFORMATION

Authority to Request Protected Health Information

The following people and/or groups may request my Protected Health Information:

Principal Investigator and Research Staff

Authority to Release Protected Health Information

The RHWP may release the information identified in this authorization from my medical records and provide this information to:

Health Care Providers at the RHWP
Study Sponsor
Data Coordinators
Data Safety Monitoring Boards
Others as Required by Law

Principal Investigator and Research Staff
Research Collaborators
Institutional Review Boards
Government/Health Agencies

Once your health information has been disclosed to anyone outside of this study, the information may no longer be protected under this authorization.

Type of Information that may be Released

The following types of information may be used for the conduct of this research:

☐ Complete health record ☐ Diagnosis & treatment codes X Discharge summary

☐ History and physical exam ☐ Consultation reports ☐ Progress notes

☐ Laboratory test results ☐ X-ray reports ☐ X-ray films / images

☐ Photographs, videotapes ☐ Complete billing record ☐ Itemized bill

☐ Information about drug or alcohol abuse ☐ Information about Hepatitis B or C tests

☐ Information about psychiatric care ☐ Information about sexually transmitted diseases

☐ Other (specify):

Right to Revoke Authorization and Re-disclosure

You may change your mind and revoke (take back) the right to use your protected health information at any time. Even if you revoke this Authorization, the researchers may still use or disclose health information they have already collected about you for this study. If you revoke this Authorization you may no longer be allowed to participate in the research study. To revoke this Authorization, you must write to the Principal Investigator.

BENEFITS TO YOU AND OTHERS

You may not get any direct benefit from this study, but, the information we learn from people in this study may help us design ways to improve care transitions from the ED.

COSTS

There are no costs for participating in this study other than the time that you usually spend in your interview.

PAYMENT FOR PARTICIPATION

You will receive $15 cash at the end of the interview.

You may be asked to provide your social security number in order to receive payment for your participation. Your social security number is required by federal law. It will not be included in any information collected about you for this research. Your social security number will be kept confidential and will only be used in order to process payment.

ALTERNATIVES

The alternative is not to participate.

CONFIDENTIALITY

Potentially identifiable information about you will consist of interview notes and recordings and survey responses. Data is being collected only for research purposes. The interview will be audio recorded, but no names will be recorded. The notes will be stored in a locked cabinet. The digital recording will be stored on a secure server at VCU. After the project is completed the recording will be destroyed. The information from the questionnaire will be stored in a secure online database. Access to all data will be limited to study personnel. What we find from this study may be presented at meetings or published in papers, but your name will not ever be used in these presentations or papers.

VOLUNTARY PARTICIPATION AND WITHDRAWAL

You do not have to participate in this study. If you choose to participate, you may stop at any time without any penalty. You may also choose not to answer particular questions that are asked in the study. Your decision to stop participating in the study will not impact your other care, services, or benefits that you receive from the RHWP or (name omitted).

QUESTIONS

If you wish to stop your participation in this research study for any reason or have any questions, concerns or complaints about the research, you should contact the principal investigator: Leticia Moczygemba at (804)-827-2253. If you have questions about enrolling in this study, you should contact:

Toni Coe at (804)-601-6841 or abcoe@vcu.edu

The researcher/study staff named above is the best person(s) to call for questions about your participation in this study.

This study was approved by Virginia Commonwealth University Institutional Review Boards.

If you have any general questions about your rights as a participant in this or any other research, you may contact:

Office of Research

Virginia Commonwealth University

800 East Leigh Street, Suite 3000

P.O. Box 980568

Richmond, VA 23298

Telephone: (804) 827-2157

Contact this number for general questions, concerns or complaints about research. You may also call this number if you cannot reach the research team or if you wish to talk with someone else. General information about participation in research studies can also be found at http://www.research.vcu.edu/irb/volunteers.htm.

CONSENT

I have been given the chance to read this consent form. I understand the information about this study. Questions that I wanted to ask about the study have been answered. My signature says that I am willing to participate in this study. I will receive a copy of the consent form once I have agreed to participate.

Participant name printed Participant signature Date

_____ _____ _____

Name of Person Conducting Informed Consent

Discussion / Witness

(Printed)

_____ _____

Signature of Person Conducting Informed Consent Date

Discussion / Witness

_____ _____

Principal Investigator Signature (if different from above) Date

Evaluator Questions to Assess Understanding

Directions:

This instrument is designed for an investigator/evaluator to use to evaluate for satisfactory of understanding of a research subject following the informed consent discussion. The evaluator should ask the subject the following questions. The intent is that the subject will indicate a solid understanding of what has been presented. However, the role of the evaluator is to use his or her best judgment to interpret the responses as a "Yes" "No" or "Unsure". **The evaluator may certainly use different wording in asking the questions in order to assist the subject's understanding of the question.** The process of using this instrument will often generate more discussion regarding the proposed research that will help to ensure that subjects are fully informed about research participation.

1. Do you understand that your research study participation is voluntary?

____Yes ____No ____Unsure

2. Can you name risks of study participation?

____Yes ____No ____Unsure

3. What will you be expected to do as part of your participation in this research study?

____Yes ____No ____Unsure

4. Do you understand that you have a right to stop participating in this research study at any time?

____Yes ____No ____Unsure

Evaluator's Statement/Signature

Is the subject able to communicate with the evaluator and give acceptable answers to the questions above?

____*Yes: The evaluator should document understanding on the consent form.*

____*No: The subject may not have understood the information provided to them during the informed consent process. Written consent will not be sought and the subject will not be enrolled in this study.*

Document on signed consent form:

It is my opinion that the subject is able to communicate and gave acceptable answers during the informed consent process.

_____

Printed Name of Evaluator and Title or Role, in Relationship to Research Project

_____ _____

Evaluator's Signature Date

Appendix 2. Recruitment Flyer for Aim 1 Interviews

Have you visited the Emergency Room in the last 30 days?

You are invited to participate in a research study.

Study Purpose: To identify reasons for emergency room use and any problems that occur after leaving the emergency room

Information about the research:

- This study involves answering questions during an interview.
- Duration: Approximately 1 hour
- Location: [redacted]

If you:

- **Have visited the Emergency Room in the last 30 days**
- **Live at** [redacted]
- **Are 18 years of age or older**

Then you may be eligible for this study.

Compensation available to individuals who participate.

Please call Toni Coe, Virginia Commonwealth University School of Pharmacy, at 804-601-6841 if you are interested in participating or have questions.

Toni Coe 804-601-6841 | Toni Coe 804-601-6841 | Toni Coe 804-601-6841 | Toni Coe 804-601-6841 | Toni Coe 804-601-6841 | Toni Coe 804-601-6841 | Toni Coe 804-601-6841 | Toni Coe 804-601-6841 | Toni Coe 804-601-6841 | Toni Coe 804-601-6841 | Toni Coe 804-601-6841

Appendix 3. Aim 1 Interview Documents

Introduction

Hello, my name is Toni and I am a graduate student at VCU School of Pharmacy. Thank you for taking the time to participate in this interview about recent visit to the emergency department or ED. I will be leading this interview and will also be audio-taping this session to make sure that I do not miss your comments. I will also take notes during this interview. After the recording is transcribed, I will delete the recording.

The purpose of this research study is to identify problems that occur when going from the emergency department (ED) and home and reasons for ED use. You are being asked to participate in this study because you visited an ED within the last 30 days. I would like to get your honest feedback and answers to the questions asked today. All information gathered today will be kept in confidence and your name will not be tied to your comments. Information gathered today will help us learn about why older adults use the ED and any problems that might occur after visiting the ED.

Please stop me at any time if you do not understand the question or if something is unclear. I have a set list of questions prepared, however, I may ask additional probing questions to understand your responses or add questions based on our discussion. You do not have to answer any question that you do not feel comfortable answering.

(Note to Facilitator: Note date and time of interview, interview number)

(Start Recording)

Interview questions [a]

Reason for ED visit questions

1. Which ED did you visit? _____

   When? _____

2. Please describe your reason for using the ED. If for a non-urgent reason, why did you choose to go to the ED? _____

   _____

   _____

   _____

   _____

3. How did you arrive to the ED? _____

   _____

   _____

4. What tests did they perform in the ED? _____

   _____

   _____

   _____

5. How did the ED visit help your problem? _____

   _____

   _____

   _____

6. How long did you have the problem associated with your ED visit? _____

_____

_____

7. Did you see a health care provider for this problem before going to the ED? If so, who?

_____

_____

_____

_____

8. What medications were you on prior to going to the ED? _____

_____

_____

_____

Were there any recent changes to your medications? _____

_____

_____

_____

Transitions of Care based upon Coleman's Care Transition Intervention

Medication Management

1. Were you prescribed any medication in the ED to take after your visit? _____

If yes, which medications? _____

_____

_____

_____

_____

2. Did you get your medications filled after your ED visit? _____

   If no, why not? _____

   _____

   _____

3. Do you use a pillbox or other reminder system to manage your medications? _____

   _____

   _____

4. Do you have a current medication list? _____

Personal Health Record

1. Do you have a personal health record?

   (The personal health record should include an active problem list, medications and allergies, whether advance care directives had been completed, and a list of red flags, or warning symptoms or signs for the patient's chronic illnesses. Space should be available for the patient to record questions and concerns in preparation for his or her next encounter. If patient brought information from ED visit, please review.)

   _____

   _____

   _____

2. What information do you have to provide to your primary care doctor or other healthcare provider about your recent ED visit? _____

_____

_____

Did you get a copy of your care plan? _____

_____

Follow-up

1. What health care providers are you supposed to see for follow-up? _____

_____

_____

_____

2. Have you seen them? _____

_____

Have you made the appointment? _____

_____

3. What did you share about your ED visit? _____

_____

_____

_____

_____

"Red Flags"

1. What are the warning signs and symptoms that your condition is getting worse?

_____

_____

_____

2. What are you supposed to do if you notice your condition is getting worse?

_____

_____

_____

[a] The following are examples of probing questions that may be asked to further understand the Participant's responses:

Would you give me an example?

Can you say some more about that?

Would you explain that further?

I am not sure I understand what you are saying. Could you rephrase your answer?

How did that come about?

Is there anything else?

Questionnaire for demographic and health-related variables collected during resident interviews

Date: _____ **Interview number: _____**

Demographics

1. **What is your age? _____**
2. **What is your gender?** Male □ Female □

3. **What is your marital status?** Never married □ Married □ Divorced □ Widowed □

4. **What is your race or ethnicity?** Caucasian □ African-American □ Native American □

   Hispanic □ Asian □ Other □ _____

5. **What is the highest level of education or grade that you completed?**

   _____

   Highest level education completed: _____

6. **What is your health literacy (grade level) as assessed by the REALM-SF[a]?**

   ≤ 3rd grade □ 4th-6th grade □ 7th-8th grade □ ≥ 9th grade □

7. **What type of health insurance do you have?** Medicare □ Medicaid □

   Medicare-Medicaid Dual Eligible □ None □ Other □_____

8. **What is your yearly income?**

   <$9,999 □ $10,000-19,999 □ ≥ $20,000 □

9. **Do you have anyone to help with your care?** Yes □ No □

   If yes, who?

   _____

10. **Do you have a regular source of transportation?** Yes □ No □

    If yes, what type and who?

    _____

11. **Do you have a telephone?** Yes □ No □

12. **Do you have a cell phone?** Yes □ No □

Health-related variables

13. **How many medications do you take (total number)?**

    _____

14. How many chronic conditions, like diabetes, do you have?

_____

15. How many mental health conditions, like depression, do you have?

_____

16. Do you have a history of substance abuse? Yes □ No □

17. Do you have a primary care physician? Yes □ No □

18. Have you visited your primary care physician in the last year? Yes □ No □

19. How many visits have you had with your primary care physician in the last year?

_____

20. Why did you go to see your primary care physician?

_____

_____

_____

21. Have you been hospitalized in the last year? Yes □ No □

22. How many times have you been hospitalized in the last year?

_____

23. Why were you hospitalized?

_____

_____

_____

24. Have you visited the emergency department in the last year? Yes □ No □

25. How many visits have you had to the emergency department in the last year (include this visit)?

_____

26. Why did you go to the emergency department?

_____

_____

_____

27. Do you participate in the Richmond Health and Wellness Program? Yes □ No □

[a] Health literacy assessed by administration of the Rapid Estimate of Adult Literacy in Medicine-Short Form (REALM-SF)

Rapid Estimate of Adult Literacy in Medicine—Short Form (REALM-SF)*

Suggested Introduction: "We are studying medical word reading in order to improve communication between healthcare providers and patients. Here is a list of medical words that may be difficult to read."

Interviewer: Show the participant the Word List.

Then say, "Starting at the top of the list, please read each word aloud to me. If you don't recognize a word, you can say 'pass' and move on to the next word. Your results will be kept strictly confidential and will not be included in your official medical records."

Interviewer: If the participant takes more than 5 seconds on a word, say "pass" and point to the next word. Hold this scoring sheet so that it is not visible to the participant.

Fat	Not scored		
Flu	Not scored		
1. Behavior	□ Correct	□ Mispronounced	□ Not attempted
2. Exercise	□ Correct	□ Mispronounced	□ Not attempted
3. Menopause	□ Correct	□ Mispronounced	□ Not attempted
4. Rectal	□ Correct	□ Mispronounced	□ Not attempted
5. Antibiotics	□ Correct	□ Mispronounced	□ Not attempted
6. Anemia	□ Correct	□ Mispronounced	□ Not attempted
7. Jaundice	□ Correct	□ Mispronounced	□ Not attempted

REALM-SF Scoring

Total Correct (0-7)	Grade Level
0	$\leq 3^{rd}$ grade
1-3	4^{th} - 6^{th} grade
4-6	7^{th} - 8^{th} grade
7	$\geq 9^{th}$ grade

Fat
Flu
Behavior
Exercise
Menopause
Rectal
Antibiotics
Anemia
Jaundice

*Arozulla AM, Yarnold PR, Bennett CL, et al. Development and validation of a short-form, rapid estimate of adult literacy in medicine. *Med Care.* 2007;45:1026-1033.

Appendix 4. Aim 3 Primary Health Plan Names used for Payment Source Categories

Appendix 4. Primary health plan names used for payment source categories	
Payment source category	**Primary health plan names**
Medicare	Medicare-A & B, Medicare A & B Second, Medicare A and B Third, Medicare A and B Fourth, Medicare B Only, Medicare B Only Second, Medicare/Managed Other, Medicare/Managed Other Second, Medicare/Managed Other Third, Medicare/Managed Other Fourth, Medicare/Managed Other Fifth, Medicare Hospice/Clinical Trials, Anthem/BCBS Medicare Products, Humana Gold Medicare PFFS, Humana Gold Medicare PFFS Second, Optima Medicare Preferred PPO, Pyramid Todays Options Medicare PFFS, Pyramid Todays Options Medicare PFFS Second, Secure Horizons Direct Medicare
Medicaid	CoventryCares of Virginia Medicaid, CoventryCares of Virginia Medicaid Second, Healthkeepers Plus Medicaid, Healthkeepers Plus Medicaid Second, Medicaid, Medicaid-2, Medicaid (MCD)-3, Optima Family Care Medicaid, Out of State Medicaid
Other	Aetna (HMO/POS), Aetna PPO, Anthem BCBS, Anthem City/County Jails, Anthem Department of Corrections, Anthem Dept of Corrections Second, Anthem PPO (Keycare), Anthem PPO (Keycare) Second, Anthem VCUHS Choicecare, CIGNA (HMO/POS), CIGNA (HMO/POS) Second, CIGNA (PPO), Cigna VCUHS Choicecare, Commercial, Commercial-2, Coventry/Southern Health HMO/POS, Coventry/Southern Health HMO/POS Second, Coventry National Network Second, Federal Black Lung Program, Healthkeepers (HMO/POS), Group Billing Visit Level, Healthkeepers (HMO/POS) Second, Healthkeepers Open Access, Healthkeepers Open Accsss Second, HMO VA Premier (VCHP), Liability Insurance, Multiplan Preferred Network, OneNet PPO Second, Optima Family Care MAP Second, Optima HMO/POS, Other Managed Care, Other Managed Care Second, Out Of State BCBS, Out Of State BCBS Second, Personal Injury, Riverside PACE, United Healthcare (HMO/POS), United Healthcare (PPO), United Resources Network, VA Premier, Worker's Compensation-Varies
Tricare/VA	Tricare Other, Tricare Prime, Veteran's Administration
Self-Pay	Auto Assigned Self Pay
Virginia Coordinated Care (VCC)	HMO VCC NonCity 10% Copay, HMO VCC NonCity 25% Copay, HMO VCC NonCity 50% Copay, HMO VCC NonCity 75% Copay, HMO VCC NonCity 100% Adjust
Indigent	Indigent Care 5% Co-pay, Indigent Care 20% Co-pay, Indigent Care 45% Copay, Indigent Care-75% Copay, Indigent Care-100% Adjust

Vita

Antoinette Bartolotta Coe (née Bartolotta) was born on November 11, 1974, in Pittsburgh, Pennsylvania and is an American citizen. She graduated from Bethel Park Senior High School, Bethel Park, Pennsylvania in 1992. She received her Bachelor of Arts in Biology from Washington and Jefferson College, Washington, Pennsylvania in 1996 and subsequently worked as a forensic scientist. She received her Doctor of Pharmacy degree from Virginia Commonwealth University in Richmond, Virginia in 2009. In 2010, she completed a Community Pharmacy Practice Residency with Virginia Commonwealth University School of Pharmacy and Martin's Pharmacy. She practiced as a community pharmacist in Richmond, Virginia from 2009 - 2014.