EMERGENCY DEPARTMENT FREQUENT USERS: A LATENT CLASS ANALYSIS AND ECONOMIC EVALUATION TO POTENTIALLY GUIDE UTILIZATION MANAGEMENT INTERVENTIONS

A dissertation submitted to Kent State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy

By Lauren E. Birmingham
August, 2017
Dissertation written by
Lauren E. Birmingham
B.A., Kent State University, 2009
B.B.A., Kent State University, 2009
M.A., Kent State University, 2010
Ph.D., Kent State University, 2017

Approved by

Jonathan VanGeest, PhD, Chair, Doctoral Dissertation Committee
Vinay Cheruvu, PhD, Member, Doctoral Dissertation Committee
John Hoornbeek, PhD, Member, Doctoral Dissertation Committee
Kirk Stiffler, MD, Consultant, Doctoral Dissertation Committee

Accepted by

Sonia Alemagno, PhD, Dean, College of Public Health*
Dedication

To my parents—thank you for your undying support. There are not many parents that would request a copy of their child’s dissertation with the full intent of reading it and discussing the contents at the next family dinner. Your inherent desire to learn forever has become mine. That is a wonderful gift to have received.

To my husband, Chris—thank you for being my rock. Through all the frustration, indecision, and time spent away from home, you have been a constant source of support. Your encouragement helped me discover my passion and power, and has led to a higher level of life satisfaction than I could have ever imagined. You did not help me weather the storm; you showed me that it was not really storming after all.
Table of Contents

List of Figures ........................................................................................................................................ vi
List of Tables ........................................................................................................................................ vii
Acknowledgements................................................................................................................................... ix
Chapter 1: Introduction and Statement of the Problem ............................................................................. 1
  Background ........................................................................................................................................... 1
  Growth in Emergency Department Utilization: Increases in Size and Scope of Practice ................. 10
  Utilization and Cost Issues .................................................................................................................. 16
  Focusing on Frequent Users .............................................................................................................. 30
  Research Questions ............................................................................................................................. 42
Chapter 2: Review of Literature .................................................................................................................. 43
  Characteristics of ED Frequent Users ................................................................................................. 46
  Factors Impacting ED Utilization ......................................................................................................... 55
  Cost of Care and Practical Implications of Caring for ED Frequent Users ......................................... 69
  Creating Better Interventions by Targeting Homogeneous Groups .................................................. 73
Chapter 3: Methods ..................................................................................................................................... 78
  Data Sources ....................................................................................................................................... 79
  Variables to be used in LCA .................................................................................................................. 80
  Statistical Analysis .............................................................................................................................. 88
  Model Fit and Model Selection ........................................................................................................... 90
  Examination of Grouping Variables and Covariates .......................................................................... 90
Group Assignment ........................................................................................................................................ 91
Cost Analysis .................................................................................................................................................. 91

Chapter 4: Data Analysis .................................................................................................................................. 93

Latent Class Analysis ......................................................................................................................................... 98
Model-building .................................................................................................................................................. 98
Model Selection ................................................................................................................................................ 100
Evaluation of Gender as a Grouping Variable ................................................................................................. 102
Evaluation of Covariates ................................................................................................................................... 103
Final Model ....................................................................................................................................................... 104
Differences between Subgroups .......................................................................................................................... 106
Naming the Latent Classes ................................................................................................................................. 108
Cost-Analysis .................................................................................................................................................... 111

Chapter 5: Discussion ......................................................................................................................................... 115

Why do this Type of Research? .......................................................................................................................... 128
Future Research .................................................................................................................................................. 132
Strengths and Weaknesses ................................................................................................................................. 134
Conclusion .......................................................................................................................................................... 137

References ......................................................................................................................................................... 139
## List of Figures

<table>
<thead>
<tr>
<th>Table Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1: Excerpt on Nonemergent ED Visits Overtime</td>
<td>23</td>
</tr>
<tr>
<td>Figure 2: AHA Chartbook: Increasing burden of ED visits and Decreasing supply of EDs, 1994-2014</td>
<td>29</td>
</tr>
<tr>
<td>Figure 3: Camden Coalition of Healthcare Providers Cluster Analysis Plot</td>
<td>39</td>
</tr>
<tr>
<td>Figure 4: Histogram of 2014 ED Frequent User Visits</td>
<td>93</td>
</tr>
</tbody>
</table>
List of Tables

Table 1: Average cost of treating select primary care sensitive conditions in four different medical settings ........................................................................................................... 20

Table 2: Characteristics and Usage of Medicaid-insured ED users by the number of Annual ED visits ................................................................................................................ 44

Table 3: Demographic Characteristics of ED Users .................................................................................................................. 45

Table 4: Differences in Costs by the Number of Annual ED Visits ............................................................................................. 70

Table 5: Primary ICD-9 Diagnosis Code Categories .................................................................................................................... 82

Table 6: Chronic Disease ICD-9 Definitions ................................................................................................................................. 84

Table 7: Charlson Comorbidity Algorithm ................................................................................................................................. 87

Table 8: Continuous and Count Descriptive Statistics of the ED Frequent User Population (n=5,731) .................................................................................................................. 95

Table 9: Categorical Demographic Descriptive Variables (n=5,731) .............................................................................................. 96

Table 10: Categorical Clinically Relevant Descriptive Variables (n=5,731) ...................................................................................... 97

Table 11: Latent Class Model Fit Statistics ................................................................................................................................. 99

Table 12: Multi-class Model Fit Statistics ......................................................................................................................................... 102

Table 13: Odds ratio estimates for the Covariate Socioeconomic Status .......................................................................................... 104

Table 14: Final Model, Adjusted Latent Class Analysis Class Membership & Item-Response Probabilities ................................................................................................................. 105

Table 15: Descriptive Statistics of Latent Classes ....................................................................................................................... 107
Table 16: Latent Class Subgroup Names and their Defining Attributes............................. 111
Table 17: Cost analysis of ED Frequent User Subgroups.................................................. 112
Table 18: Fixed vs. Variable Costs by ED Frequent User Subgroups.................................. 113
Acknowledgements

I would first like to express my thanks to my advisor, Dr. Jonathan VanGeest, for his tireless support and encouragement throughout the development of this dissertation. In retrospect, I did not know what I was getting into two years ago. There were times that the revisions felt endless, and the concept of a completed dissertation seemed like an eternally distant mirage. However, Dr. VanGeest was always a vigilant backbone of support with a plan on how to move forward. Not only did Dr. VanGeest provide much-needed guidance on preparing a dissertation, he simultaneously provided mentorship during a critical point in my career. For his guidance and mentorship, I am forever grateful. Thank you.

Additionally, I would like to thank my faculty committee members, Dr. John Hoornbeek and Dr. Vinay Cheruvu for sharing their expertise and guiding my efforts. Dr. Cheruvu kindly gave me his time as I worked through the analysis and interpretation of data during this project, often asking difficult questions that could not be answered without further study, analysis, and consideration. Thank you for challenging me to think beyond just the numbers. Dr. Hoornbeek provided a unique perspective on this project that repeatedly led to bigger and better thinking. His feedback at the end of this project was most appreciated, and truly improved the quality and usefulness of the end product.

I would like to extend a great deal of thanks to Dr. Kirk Stiffler who served as a consultant on this dissertation. Dr. Stiffler provided thoughtful feedback and comments at many times throughout this project. His comments were always thoughtful and comprehensive, grounded not only in knowledge of the literature, but also in personal experience as an emergency medicine physician.

I owe a great deal of thanks to the emergency department research team that helped guide me through this process. Dr. Jennifer Frey and Dr. Scott Wilber both provided a great deal of assistance with this project, and the prior study that led to the development of this work. Dr. Wilber and others in the ED took a chance on hiring an economist turned Public Health student with no clinical know-how. In
many ways, I credit that opportunity for the happiness and satisfaction I have found in my current career path.

Dr. Frey has been an enormous resource to me over the past three years. She has gone above and beyond just “showing me the ropes”. Through all the twists and turns of my dissertation, she was there to provide support and guidance. Her commitment to the conduct of proper research is something I am thankful to have learned, but her mentorship is something I am eternally grateful to have experienced.
Chapter 1: Introduction and Statement of the Problem

Background

The Emergency Department

The emergency department (ED) is the single place in the health care system where anyone can access care, regardless of ability to pay, for a full range of care—from minor cuts and scrapes, to life-saving surgery. Most emergency departments in the United States are open every day of the year, as well as at all times of the day and night. Emergency medical transportation services have increased the accessibility of the emergency department to people who are unable to drive, who do not live within a reasonable driving distance to an emergency department, or those who have no access to transportation. The advent of EDs and emergency medical transportation, paired with policy requiring health care providers to provide emergency medical treatment, has resulted in people being able to access emergency medical care, who would otherwise not receive healthcare. The total availability of the ED to all has made the emergency department a staple in the public health safety net, meaning that it is a place where anyone can receive medical care—regardless of ability to pay, or irrespective of whether or not they have access to primary care physicians; a considerable deviation from the original mission of emergency departments which were established to treat time-sensitive, life-threatening illnesses and injuries.

Given the relative ease of access, emergency departments, in many instances, have become a catchall service provider for many communities—providing medical care in emergencies, but also in cases where people are otherwise unable to receive medical attention. This use of the emergency department for minor care can occur because patients do not have established primary care physicians, or because they are unable to see their established primary care physician in a reasonable amount of time, or because the health problem has presented at a day or time when the primary care physician office is not open. The sheer convenience of the ED, and lack of required appointments, may also be a
reason why patients present seeking minor care. Given the multitude and frequency of conditions under which traditionally minor care is delivered in the emergency department, the ED is indeed often used by a variety of people (not just those who are uninsured) for non-emergent conditions. This position in society as a provider of safety net services is needed because the emergency department provides care when there are no alternatives. Additionally, it offers emergency treatment for the most vulnerable populations who may not be able to receive medical otherwise. However, this service, while very important, comes at a high cost to patients, payers, and hospitals.

**Key Concepts**

**American College of Emergency Physicians:** The American College of Emergency Physicians (ACEP) is a professional organization for emergency medicine physicians. The organization offers guidance on clinical practice and advocates on behalf of emergency medicine physicians on policy-related matters. ACEP operates a peer-reviewed journal, *Annals of Emergency Medicine*. This organization is very influential in policy-matters related to emergency departments.

**Committee on Trauma & Committee on Shock:** This is in reference to the 1966 report, *Accidental Death and Disability: The Neglected Disease of Modern Society*. The Committee on Trauma and Committee on Shock were two committees within the National Research Council under the National Academy of Science that studied the delivery of emergency medical services. This work was considered a watershed moment in the history and provision of care to injured patients. This report identified that injuries were a “neglected epidemic”, with too many people dying of preventable diseases and inadequate trauma and emergency resources to care for them. This report began an era of growth for emergency medicine and trauma providers.

**Emergency Medical Treatment and Active Labor Act (EMTALA):** This was a law passed in 1986 and ensures public access to emergency services, regardless of ability to pay. The laws mandate EDs to provide life-sustaining care for those experiencing medical emergencies or active labor, or to provide
transportation to a facility that is able to provide such care—all regardless of ability to pay. EMTALA was part of the Consolidated Omnibus Budget Reconciliation Act (COBRA). COBRA was a larger bill that affected health insurance provisions for individuals and employers. EMTALA, also known as the anti-dumping law, was passed to prevent patient dumping. Patient dumping had become a common practice in the United States when hospitals encountered uninsured or Medicaid patients for whom reimbursement was unlikely or otherwise unattractive. When uninsured or underinsured patients would present to the hospital, the hospital could refuse care, or transfer them to another facility to avoid the financial risks of treating such patients, often to the detriment of the health of these patients. The establishment of EMTALA led to solidifying the place of emergency departments in the public health safety net, but has remained an unfunded government mandate.

**Freestanding Emergency Department (FSED):** A freestanding emergency department is an emergency department that is not co-located with a hospital. Rather, FSEDs are typically located in convenient community locations that are hand-selected by hospitals or health systems. Locations may also be based on community payer mix (Schuur, Baker, Freshman, Wilson, & Cutler, 2016). Not all states allow FSEDs, and the regulations on billing procedures and the types of conditions may be treated at these locations are still evolving. FSED come in two varieties—the vastly more common hospital-based off-campus emergency departments (OCED) and the more rare independent freestanding emergency centers/ departments (IFEC). The former hospital-based model (OCED), falls under the same rules as hospital-based emergency departments and must adhere to EMTALA. At this time, the latter model (IFEC) is not recognized as an emergency department by the Centers for Medicare and Medicaid Services (CMS), and as a result, these entities do not have to observe EMTALA regulations. This means that Medicare and Medicaid will not reimburse for services provided at these locations—which may explain why there are so few IFEC providers/locations. Some states have begun to pass legislation that requires IFECs to follow
the intent of EMTALA to prevent the return of patient dumping (American College of Emergency Physicians, 2014).

In general, FSED are typically not equivalent in terms of technology and staffing to a hospital-based emergency department, but most are able to handle the vast majority of emergency room fodder. FSEDs have been present in the market since the 1970s, but the number has grown exponentially in recent times with a 76% increase in the number of FSED facilities from 2008 to 2015 (Harish, Wiler, & Zane, 2016). Further growth of FSEDs is expected in the future (Gillooley, 2016).

**Medically complex patients:** The term “medically complex” can take a variety of meanings in the literature. In the context of this dissertation, medically complex is used to refer to patients that have multiple chronic conditions which may or may not be exacerbated by social determinants of health. The prevalence of medically complex patients is increasing due to several factors: increase in the elderly population as baby boomers age, the prevalence of unhealthy lifestyle practices that lead to chronic disease, and better technology to recognize and diagnose health problems. This is challenging for the health care industry as a whole as it prepares to deal with the chronically ill patient who requires medical management in a variety of care environments (home, hospital, skill nursing facilities, etc.) rather than the acutely ill patient who is managed primarily in the hospital. This is also challenging for EDs who need to be able to assess and discharge patients quickly in order to maintain operational cost-effectiveness. Medically complex patients are, as the name suggests, more complicated than the typical patient and can take more resources and longer periods of time to diagnose and treat. The increased time and resource use leads to slower ED treatment turnover rates which can, in turn, potentially increase ED wait times.

**Safety-net provider:** This is a term used to describe health care resources and providers that are available to the most vulnerable populations that cannot obtain healthcare due to inability to pay or lack of access to providers. Safety net resources are providers of last resort, or a place anyone can receive
care regardless of ability to pay. As a result of EMTALA and the very nature of the availability of ED resources, the ED has become a staple in the public health safety net (Gonzalez Morganti et al., 2013). Low income and uninsured individuals often rely on safety net providers, like emergency departments, to provide care in not only emergency situations, but also for minor care such as immunizations, check-ups, and minor health problems like ear infections and sprains/strains. Given the United States’ reliance on health insurance to institute access to health care providers, safety net providers who do not have insurance requirements are of paramount importance to some of the most vulnerable populations.

**Triage scale:** Triage scales are used by ED nursing staff to determine what level of care a patient, upon arrival to the ED, is expected to require. This practice helps to determine the resource-burden an ED bears from day-to-day. Sometimes triage scales are used to indicate how “serious” a patient’s chief compliant is, however, this is not the primary intention of the tool. While EDs use triage scales to determine resource burden levels, researchers often use triage scales to roughly measure patient acuity, although acuity is not directly measured by triage scales.

**History of the Emergency Department**

The first “accident center” opened in 1911 at the University of Louisville Hospital (then City of Louisville Hospital) under the guidance of a surgeon named Dr. Arnold Griswold (Kentucky One Hospital, n.d.). This facility was established to provide round-the-clock access to physicians to treat life-threatening injuries from accidents, which, at the time, was a novel concept. The emergency department as we know it today, however, is a relatively recent phenomenon in medical history. The first official ED (staffed by physicians dedicated to emergency care) in the United States was established in 1961 in Virginia (Suter, 2012). In 1966, a seminal work was published by the National Academy of Science describing the dismal state of emergency care in the United States (Committee on Trauma & Committee on Shock, 1966). This report outlined a number of key problems related to the state of accidents and injuries in the United States including public apathy towards injuries and related
mortality, a lack of training in basic first aid amongst most of the population, a lack of standardized injury-related data, and a lack of organization around hospital-based emergency departments.

Most notably, accidental injuries were described as a “neglected epidemic”. Public apathy and a lack of leadership were cited as the root cause of the lack of progress made in caring for accidental injuries during the 1950s and 1960s (Suter, 2012). The report notes that in 1965 107,000 deaths were caused by injury, of which motor vehicle accidents were responsible for 49,000 (Committee on Trauma & Committee on Shock, 1966). With the proliferation of motor vehicles in the 1950’s, motor vehicle accidents were reaching epidemic proportions (Centers for Disease Control and Prevention, n.d.-b). In 1950, 23.1 deaths per 100,000 population (34,763 deaths) were caused by motor vehicle accidents. A decade later, little improvement had been made with 21.3 deaths per 100,000 population (38,137 deaths) still being caused by motor vehicle accidents (Centers for Disease Control and Prevention, n.d.-b). These figures have changed significantly since the 1950s and 1960s, with the most recent mortality data from the Centers for Disease Control and Prevention finding that 11.1 deaths per 100,000 population (or 35,398 deaths) were attributable to motor vehicle accidents (Kochanek, Murphy, Xu, & Tejada-Vera, 2016).

It is largely believed that the 1966 National Academy of Science report, aptly titled “Accidental Death and Disability: The Neglected Disease of Modern Society”, was the impetus for many of the improvements in the trauma and emergency care system for treating accidents and injuries (Howard, 2000). Prior to the 1960s, few organized EMS units existed, and even fewer paramedics had advanced EMS training such as an advanced first aid course (8% of EMS workers according to one study) (Hampton, 1965). The report lead to the immediate establishment of a federal program to improve the EMS system (Shah, 2006). As a result, ambulances started to be regulated, training of EMS workers improved, and research on optimal communication systems, processes, and outcomes began, all leading to an improvement in the delivery of prehospital emergency care (Shah, 2006). Prehospital care is
known to reduce mortality from motor vehicle accidents, typically because it ensures patients are delivered to emergency departments with expediency (Marson & Thomson, 2001). Prehospital healthcare providers are playing an increasing role in the evaluation and management of patients being transported to the ED and/or hospital (Carron et al., 2015).

It should be noted that the establishment of the President’s Commission on Highway Safety (the predecessor of the National Highway Traffic Safety Administration) occurred around the same time as the 1966 report. Improvements in motor vehicle safety were also a contributor to the decrease in mortality associated with motor vehicle accidents. However, the role that prehospital and emergency care providers played in this cannot be overlooked.

One notable finding from the report from Committee on Trauma and Committee on Shock (1966) was that air ambulances had been very effectively used during military operations, but had never been adopted for civilian use, despite the inherent usefulness, especially in rural communities. During the Vietnam War news reports and photographs appeared at home showing more sophisticated trauma care than what was available to civilian trauma patients, leading to further concern about civilian emergency and trauma care (Suter, 2012). This concern and desire for more organized emergency medical care eventually lead to the establishment of the American College of Emergency Physicians (ACEP) in 1968. ACEP promotes the delivery of quality emergency medicine care to all by qualified and credentialed emergency medicine physicians. The organization considers this to be a fundamental individual right. Additionally, ACEP advocates for ED-related health policy in the United States and supports emergency medicine research and publications through its peer-reviewed journal, *Annals of Emergency Medicine*. The growth of emergency medicine as an independent specialty followed, culminating in 1972 when the American Medical Association officially recognized the field as a specialty and the field of emergency medicine was born (Suter, 2012). In 1979 the American Board of Emergency Medicine (ABEM) was approved as a specialty board, complete with a certification exam, making
emergency medicine the 23rd medical specialty in the United States (Suter, 2012). A decade later, in 1989, the American Board of Medical Specialties recognized emergency medicine with “Primary Board Status” which meant ABEM could pursue subspecialty certifications for emergency medicine physicians. Subspecialties within emergency medicine include pediatric emergency medicine, critical care, and research (SERMO, 2014).

Gonzalez Morganti et al. (2013) note that the establishment of new emergency departments began in the 1970s, after the establishment of ACEP, but proliferated during the 1980s and 1990s—especially with the onset of freestanding emergency departments. In the time period after WWII hospitals grew substantially, given the availability of federal money available to build community hospitals through the Hill Burton Act of 1946. While this legislation promoted new hospital growth, the growth of new hospitals slowed down during the 1980s and 1990s with the ascension of the hospital consolidation movement. As the number of hospitals and associated EDs shrunk, freestanding emergency departments (FSEDs) began to increase—starting as early as the 1970s (Harish et al., 2016), but growing more in the 2000s (Harish et al., 2016). During this time FSEDs become more popular, continuing the growth of emergency departments, while the number of hospital-based emergency departments shrunk. Essentially, the mix of emergency departments has changed from the 1950s to the present. While hospital-based emergency departments were more popular in the 1950s-1990s, growth in FSEDs in some states have shifted the distribution of EDs to a more dispersed model.

The emergency department has become an important revenue source for hospitals, as emergency departments are responsible for a majority of hospital admissions, the primary revenue generator for most hospitals (American College of Emergency Physicians, 2013; Gonzalez Morganti et al., 2013; Schuur & Venkatesh, 2012). However, many hospital administrators view the ED as a loss leader because of their position in the public health safety net (Hsia, Kellermann, & Shen, 2011) despite data suggesting that most EDs have healthy margins (Wilson & Cutler, 2014). Given that hospitals still need
EDs to supply revenue generating inpatients, the costs of the ED being a safety net provider are often outweighed by the benefits of being a gatekeeper to revenue generating hospital admissions. Trauma Center designation, a separate, but related issue to emergency departments, also suffers from being labeled as a loss leader by hospital administrators, despite data suggesting Trauma Center designation has a “halo effect”. The halo effect results in more patients preferring to receive even non-acute care in Trauma Centers because patients believe the quality of care received in these facilities is greater than non-Trauma Center facilities (Josephs, 2013). Thus maintaining Trauma Center designation is one strategy to maintain the flow of admissions (even non-trauma related) and preserve market share.

Given the growing role of the ED as the gatekeeper to the majority of inpatient admissions, the ED is viewed as a critical part of the hospital (Gonzalez Morganti et al., 2013).

Growth in emergency departments and changes in the legal and regulatory environment have led EDs to the role they play today in the public health infrastructure as safety net providers. For individuals without health insurance, access to primary care is typically more limited than it is for those with health insurance. EDs emerged as a provider of last resort for uninsured patients as increasing numbers of private primary care physicians chose not to accept uninsured patients. This role became more prominent after the passage of the EMTALA legislation, which mandates public EDs to provide a baseline level of care, regardless of a patient’s ability to pay. The growth in EDs throughout communities across the United States has increased access to EDs, making it easier for all, including the uninsured, to access the ED for care. As a result, EDs have long provided primary care services for the most vulnerable populations (New England Healthcare Initiative, 2010; Rhodes, Gordon, & Lowe, 2000; Weiss, Wier, Stocks, & Blanchard, 2014), and may be the only place where some populations can receive any form of medical care, given an unfavorable or non-insured status (Billings, Parikh, & Mijanovich, 2000a). So, while the ED plays a critical role in the care of the most acute patients, it also provides low acuity care for some of the most vulnerable patients in communities across the United States.
Growth in Emergency Department Utilization: Increases in Size and Scope of Practice

Emergency department usage has continued to grow since its inception (Tang, Stein, Hsia, Maselli, & Gonzales, 2010), with evidence of increased ED utilization at every decade since the very beginnings of emergency departments (Burt & McCaig, 2001; Christoffel, Garside, & Tokich, 1985; Jacobs, Gavett, & Wersinger, 1971; McCabe, 2001; Ullman, Block, & Stratmann, 1975). In 2013, emergency departments in the United States saw 136 million visits (Centers for Disease Control and Prevention, 2017b).

While accidents and injuries may have started the demand for emergency care, the aging population and increased complexity of disease has sustained its role in the health care industry. Better management of chronic diseases means that people live longer, and thus receive more health care for more years (Institute of Medicine, 2007). This demographic change has influenced ED usage. For instance, when the National Center for Health Statistics began the National Hospital Ambulatory Medical Care Survey (NHAMCS) in 1991, 32.7% of patients who went to the ED were treated for an injury or poisoning (McCraig, 1994). In 2012, only 21.5% of ED visits were for an injury or poisoning (Centers for Disease Control and Prevention, 2012). This data illustrates a shift away from treating only injuries and poisonings as time has progressed. The diagnoses that ED physicians treat have also evolved over time. Between 1991 and 2012, an increase in the rate of ED visits per 100 population increased for visits related to: (1) endocrine, nutritional, metabolic diseases, and immunity disorders, (2) mental disorders, (3) diseases of the genitourinary system, (4) diseases of the skin and connective tissue, (5) diseases of the musculoskeletal system and connective tissue, and (6) diseases classified as “other” (Centers for Disease Control and Prevention, 2012; McCraig, 1994).

Furthermore, patients presenting to the ED have also become more medically complex, with 28% of Americans having two or more chronic conditions (Anderson, 2010). This increased complexity increases the burden on emergency departments because more complex cases typically require more
time to treat, and may require additional consults with specialist physicians (Anderson, 2010). Given how frequently EDs touch high-need medically complex patients, it has been suggested that EDs are taking a greater role in care management of the medically complex, indicating that this role in the management of medically complex patients may continue to expand—especially in light of the more common value-based reimbursement models (Carrier, Yee, & Holzwart, 2011; McClelland et al., 2014; Schrijvers, 2008). Value-based reimbursement models place more financial risk upon providers by tying reimbursement to quality metrics. This is a policy strategy aimed to make health care providers provide higher quality care and control costs, which is very much the opposite of the traditional fee-for-service model.

Additionally, with the full battery of technology available to ED physicians and staff, almost any level of care can be delivered in the ED, including care for the elderly and the medically complex, greatly expanding the scope of services provided beyond its original conception (Pitts, Pines, Handrigan, & Kellermann, 2012). This has been described by Gonzalez Morganti et al. (2013) in their discussion of ED service use; with EDs characterized by increases in “practice intensity”, a term describing the synergistic effect of increasingly sick patients presenting to the ED and the availability of increasingly advanced technologies being available to ED physicians for diagnosis and treatment, resulting in a dramatic increase in the size and scope of evaluations done for patients in the ED.

This increase in the scope of health services provided in the ED does not stop at traditional physical medicine. The emergency department has increasingly become a source of care for psychiatric emergencies with studies demonstrating that 10% of ED patients present to the ED with a psychiatric condition (Wilson, Pepper, Currier, Holloman, & Feifel, 2012; Zun, 2016). Research indicates that ED visits for psychiatric emergencies have increased in recent years (Larkin, Claassen, Emond, Pelletier, & Camargo, 2005). Funding cuts to mental health occurred in 1981 with the passage of the Omnibus Budget Reconciliation Act. This legislation led to a 30% reduction in federal money available for the
provision of mental health services (Osher, 2016). Two decades later the situation was worsened by the economic downturn following the housing bubble, and further state budget cuts to mental health were made, totaling approximately $4 billion (Osher, 2016). Further complicating matters has been the increase in ED visits for substance abuse, which has most recently been exacerbated by the growing heroin epidemic (Centers for Disease Control and Prevention, n.d.-a; Centers for Disease Control and Prevention (CDC), 2015). The consequences of cuts to mental health funding are vast, but include increased visits to emergency departments and hospitals (National Alliance on Mental Illness, 2011).

The increase in ED utilization for psychiatric and behavioral health care is believed to be in part due to the deinstitutionalization of patients with mental health illnesses (Alakeson, Pande, & Ludwig, 2010). As less inpatient mental health resources have become available for the population, pressure on emergency departments has increased. The result has been “ED boarding”, a term that describes how patients, in this case psychiatric and behavioral health patients, are kept in the ED until other inpatient arrangements can be made. Unlike traditional ED to inpatient care, where patients are typically transferred to units within a hospital, psychiatric emergencies often need to go to off-site locations (dependent on availability and insurance). A study that measured the effects of psychiatric patient boarding in EDs found that the mean ED length of stay (LOS) for psychiatric patients was 1,089 minutes, while the average ED LOS for non-psychiatric patients was 340 minutes (Nicks & Manthey, 2012). It was estimated that the average opportunity cost of seeing one psychiatric patient in the ED was $2,264 per patient (Nicks & Manthey, 2012). Additionally, it takes on average twice as long to find a psychiatric patient an inpatient hospital bed than for a non-psychiatric patient—adding to the frustration providers experience dealing with these patients (Zeller, n.d.). This is only complicated by patients who lack insurance, and who thus may not be eligible for admittance to many psychiatric and behavioral health facilities. These factors increase ED staff burden, decrease ED bed turnover (or throughput), decrease
financial performance of emergency departments, and is not optimal patient treatment for those experiencing psychiatric emergencies (Alakeson et al., 2010; Nicks & Manthey, 2012).

Lest it not be forgotten, as previously mentioned, the ED is also a primary care provider for patients without established primary care physicians. Despite the known benefits of having an established primary care physician, 19.9% of U.S. adults do not have a usual source of health care (Agency for Healthcare Research and Quality, 2017). Many individuals, especially low-income individuals, prefer to go to the ED for treatment because they believe it is better quality care that can otherwise be obtained (Kangovi et al., 2013). For some, however, there may be no alternative to the ED for even non-acute care. Data have shown that 16.9% of ED visitors did not have an identified usual source of care at their ED visit (Weber, Showstack, Hunt, Colby, & Callaham, 2005). Many primary care physicians will not see a new sick patient if they are not already established at the practice, thus those who are not established with a primary care physician may have no alternative to the ED if they are sick. While the role of urgent care centers is still developing, many urgent care centers will not accept patients without insurance or with Medicaid insurance, or may charge copayments up front, preventing those without funds from being able to receive services, and thus further promoting the utilization of the ED for minor care (Medicaid Access Study, 1994).

Additionally, the ED is often times a primary care provider for patients who cannot get an appointment with their physician in a reasonable amount of time. As a result patients are either referred to the ED by their primary care physician, or may decide themselves to not wait until the primary care physician is available. In a survey of ED frequent users, 28% stated that their regular physician had referred them to the ED (Birmingham, Cochran, Frey, Stiffler, & Wilber, 2017). Primary care referrals to the ED are an increasing source of ED visits (Gonzalez Morganti et al., 2013; New England Healthcare Initiative, 2010). A 2011 poll conducted by the American College of Emergency Physicians (ACEP) found that 97% of surveyed physicians stated that they treat at least one patient per day who is referred to the
ED by their primary care physician (ACEP, 2011). It has been suggested that the ability of the ED to quickly diagnose and treat issues is the reason for this behavior, which may be a function of the variety of technology that is immediately available to emergency physicians, but not available to primary care physicians (Pitts et al., 2012). Other possible reasons for primary care physicians referring patients to the ED may be busy primary care schedules, and concern that patients may need a medical screening examination to rule out any immediate health threats. It has also been suggested that primary care referrals to the ED are a way for primary care physicians to avoid treating low margin patients (Gonzalez Morganti et al., 2013). Despite the reason for the referral, primary care referrals to the ED are a major source of ED visits.

The relationship between primary care and the emergency department is complicated. Most Americans report having a usual source of care (Viera, Pathman, & Garrett, 2006). However, having an established source of care does not guarantee access when an unexpected health concern arises. Not being able to access a usual source of care when experiencing a health problem is associated with emergency department use (Rust et al., 2008). According to Rust et al. (2008) patients who had a usual source of medical care were more likely to visit the ED when they could not reach their usual source of care by phone, had to wait too long in the waiting room, could not get an appointment in a perceived appropriate amount of time, or were not open when the health problem arose. For this reason, those who have usual sources of care may still choose the ED for minor health care issues because they have no perceived feasible alternative exists.

While perhaps outside the original intention of emergency departments, EDs clearly function as a provider of last resort, or safety net provider, to those who do not have access to other physicians. This is often a function of payer status (or lack thereof). Both uninsured and underinsured are included. As can be expected, those who are uninsured or underinsured typically do not have an established primary care physician, or regular source of care. The role of underinsurance cannot be understated, as
high deductible insurance plans become more common. According to a report from the Commonwealth Fund, 11% of privately insured adults have a deductible of at least $3000, leaving many individuals effectively uninsured because they cannot afford their deductibles (Commonwealth Fund, 2015). To complicate matters, the rate charged for a self-pay (uninsured) patient is often higher than the rate someone with insurance is charged—making for a substantial financial burden to receiving primary care (Saloner, Polsky, Kenney, Hempstead, & Rhodes, 2015). A regular source of care is associated with receipt of preventative care services that prevent or delay the onset of disease—preventing early mortality, morbidity, and costs (Bindman, Grumbach, Osmond, Vranizan, & Stewart, 1996). Thus, the uninsured or underinsured often do not get the primary care they need- resulting in poorer health outcomes overtime.

Data on the uninsured is illustrative of possible impacts on ED utilization. Data from 2016 demonstrate that the percent of uninsured individuals was consistently at approximately 15% of the population before the implementation of the Affordable Care Act (ACA) (Obama, 2016). While one would theoretically expect ED visits to decrease after the ACA implementation, since the formerly uninsured people would have gained access to primary care physicians—this did not come to fruition. Rather, there have been reported increases in ED volumes post ACA implementation (Dresden et al., 2017). This highlights a nuance of insurance access—insurance access does not guarantee that primary or preventative physician care will be received. Experimental work, prior to the ACA showed this to be true as ED visits rose after individuals newly acquired health insurance (Baicker & Finkelstein, 2011; Taubman, Allen, Wright, Baicker, & Finkelstein, 2014). The evidence is mixed on whether or not the spike in ED visits will be sustained over the long-term. One study in California showed that the increase was not sustained (Lo et al., 2014), while another study in Oregon showed that the increase was sustained (Finkelstein, Taubman, Allen, Wright, & Baicker, 2016). A result of the work on evaluating Medicaid expansion has been a common understanding that access does not guarantee that patients
will use the proper level of healthcare utilization, and that there is a learning curve associated with health insurance, primary care establishment, and ED utilization. Thus, even after successful reduction in the rate of uninsured individuals—emergency department visits may not decrease after all, without further intervention.

**Utilization and Cost Issues**

While strides have been made in many areas with respect to emergency medical care, challenges still remain. The high cost of healthcare in the United States is a well-documented problem (Hagist & Kotlikoff, 2005; Squires, 2013, March 21), and emergency medical expenditures make up a substantial portion of that burden (Lee, Schuur, & Zink, 2013). As previously discussed, the increase in practice intensity—or the synergistic increase in the amount and scope of diagnostic and treatment activity performed in the ED—together with the increase in medically complex patients—has increased the cost of ED services (Gonzalez Morganti et al., 2013; Pitts et al., 2012). This effect is magnified by the growing number of elderly baby boomers experiencing health problems associated with old age and end of life. The result of this increase in practice intensity and growth in the elderly population is unsustainable cost growth which is further complicated by the previously discussed utilization rates among the uninsured and underinsured.

The most recent expenditure data shows that 17.5% of the gross domestic product (GDP) was spent on healthcare, with healthcare spending at approximately $3 trillion (Centers for Medicare and Medicaid, 2015). This is higher than the average of other countries in the Organizations for Economic Cooperation and Development (OECD) which average 9% of GDP spending on healthcare (Lazarus, 2016). On a per capita basis, the US spends $9,403 per capita on healthcare, as of 2014, up from $3,788 in 1995 (The World Health Organization, 2017). It has been estimated that spending on ED care in 2010 was $136 billion, or 5.2% of national health expenditures, although some estimates are as high as 10% (Lee et al., 2013). An analysis of the 2010 Medical Expenditure Panel Survey (MEPS), produced a more
conservative figure, estimating that total spending on emergency department care was $48.3 billion, or approximately 2% of all national health expenditures (Lee et al., 2013). Similarly, data from 1987 MEPS showed that total ED expenditures represented 1.9% of national health expenditures—suggesting that ED expenditures have maintained a relatively consistent share of health care expenditures over time (Tyrance, Himmelstein, & Woolhandler, 1996).

As healthcare costs continue to increase at rates that have historically outpaced inflation, this increase in absolute number of dollars allocated to ED care will not be sustainable. Even as of 2009, when Auerbach and Kellermann (2011) wrote that increases in 2009 median real income gains were almost entirely wiped out by increases in health care costs, it was known that this continual increase in healthcare costs—from the ED and elsewhere—were not viable. The trend of increasing healthcare costs still continues today, with the most recent data predicting a 6.5% increase in health care costs for 2017 (PriceWaterhouseCoopers, 2016). Medicare alone has seen an average annual growth rate of per enrollee spending of 7.5% from 1969-2013 (Kaiser Family Foundation, 2015). This becomes especially unsustainable from the individual perspective with more cost-sharing being pushed on individuals and families. Annual deductibles have been a common way for employers to pass greater cost-sharing onto employees. From 2006 to 2016 the average deductible increased 153% for workers covered by employer-sponsored insurance (Claxton et al., 2016). This increase in costs is unsustainable from both an individual and societal perspective.

Rising healthcare costs are due to many factors including the previously discussed increases in ED utilization and related scope of services provided. Also important are the advances in the technology available to ED physicians. Increases in the number of ED visits over time and the expansion of the scope of practice in the ED have been discussed previously (Tang et al., 2010). As can be expected, both result in upward pressure on ED and overall healthcare costs. Treating more complex patients who have longer lengths of stay, or who require larger clinical workups, clearly cause the costs of treatment to rise. ED
patients have already been established as increasingly medically complex (Anderson, 2010), increasing resource burden on EDs in terms of time spent with patients, and the number and scope of consultations, tests, and procedures required to discharge a patient. While in the past an elderly patient may have presented with a hip fracture as a result of a fall, now, with the high prevalence of chronic disease, a hip fracture can easily occur with comorbid obesity, atrial fibrillation, depression, and arthritis—complicating the ED visit, and subsequent hospital stay. Lastly, with increases in technology, ED patients are subject to increased battery of tests and procedures in the ED (Niska, Bhuiya, & Xu, 2010; Pitts et al., 2012). Advances in technology also contribute to increasing costs. Technology can greatly augment a clinician’s ability to timely diagnose and treat illness which is why it is increasingly utilized in the ED setting. Evidence suggests that just under half (44.4%) of all ED visitors receive some type of imaging procedure (Niska et al., 2010). This suggests that patients who present to the ED may clinically require imaging, or that, because ED physicians are easily able to image patients, imaging is frequently used, supporting a supply-induced demand theory (Fisher & Wennberg, 2003). No matter the reason for presentation, ED patients often receive imaging procedures, as well as blood work and urinalysis that, had the patient visited a primary care office, may not have been performed (Niska et al., 2010). It is known that the use of diagnostic imaging varies greatly in emergency departments and is not correlated with high quality care (Hoffman & Cooper, 2012; Kanzaria, Hall, Moore, & Burstin, 2015). However, the use of diagnostic imaging continues to be used at high levels in the ED. The costs of imaging are substantial, with traditional Medicare beneficiaries spending $9.3 billion for imaging services alone in 2014 (Medicare Payment Advisory Committee, 2016). In short, ED visits are increasing while the cost of the visit simultaneously increases, resulting in increased health care expenses associated with emergency care. Furthermore, not all of the increases in costs are associated with increased benefit.
Rising healthcare costs are also due to a behavior called defensive medicine. Defensive medicine is a practice where healthcare providers overuse tests and procedures to rule out all possible causes of illness, despite the inefficiencies this causes, for fear of being sued at a later date. This increases the intensity, and associated costs, of services delivered in all areas of the healthcare delivery, including the ED. Estimated costs for defensive medicine practices were $45 billion in 2008 (Mello, Chandra, Gawande, & Studdert, 2010). It has been estimated that 28% of medical orders and 13% of costs are delivered in part out of concerns of litigation, and approximately 3% of costs are completely for defensive purposes (Rothberg et al., 2014). Medical students and residents are both formally and informally trained to protect themselves from malpractice risks through defensive medicine (Chanana, 2017). A survey of 68 residents showed that 53% reported that their attending physician trained them to account for potential medical liabilities in their clinical practice and decision making (O'Leary, Choi, Watson, & Williams, 2012). Thus, defensive medicine is a costly practice and, without major changes in policies (such as tort reform), this practice is likely to continue as it is part of the graduate medical education process.

As demonstrated above, emergency care is expensive from a societal perspective when the total amount spent on emergency care is examined. Emergency care is also expensive to operate from a hospital perspective. Hospital-based emergency departments, especially those with Level 1 trauma center accreditation, are expensive to operate (Shen, Hsia, & Kuzma, 2009; Zuckerman, Bazzoli, Davidoff, & LoSasso, 2001). For this reason, emergency departments, especially those located in less wealthy neighborhoods where the payer mix is typically suboptimal, have been closing at increased rates (Hsia et al., 2011; Shen et al., 2009). This trend is not limited to EDs, even hospitals have showed this trend of closing in low-income neighborhoods and opening in wealthy neighborhoods (Galewitz, 2015). It has been suggested that reduced reimbursements and increased penalties and costs of operation have caused this trend. Despite the reason for closure, hospitals that have lower margins are
typically at higher risk for closure (Ly, Jha, & Epstein, 2011). Low margin hospitals tend to treat higher proportions of Medicare patients and are located in counties with high proportions of uninsured patients (Bai & Anderson, 2016). This perpetuates and augments health disparities between low- and high-income individuals as EDs and hospitals in low-income neighborhoods close. Data suggests that emergency department closures are associated with negative health outcomes, and impact minorities, the poor, and elderly populations with higher frequency (Liu, Srebotnjak, & Hsia, 2014). In sum, the expense of healthcare is difficult to bear for patients and insurers, as well as hospital operators, leading to the need for difficult decisions to be made with respect to hospital closure.

Emergency department care is also relatively expensive from the patient perspective. However, patients are typically not informed of the costs of emergency care before they obtain it, rather they perceive it to be abstractly expensive (Hsu et al., 2004). The ED is among the most expensive places to receive medical care, as illustrated by Table 1 from Mehrotra et al. (2009). This table shows the average cost of receiving care for 3 primary care sensitive conditions (otitis media, pharyngitis, and urinary tract infection). The cost of an ED visit is five times that of a retail clinic visit, and approximately 3.5 times more expensive than a physician office visit.

Table 1: Average cost of treating select primary care sensitive conditions in four different medical settings

<table>
<thead>
<tr>
<th></th>
<th>Retail Clinic</th>
<th>Physician Office</th>
<th>Urgent Care</th>
<th>ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs, 95%CI</td>
<td>$110 (97, 123)</td>
<td>$166 (162,170)</td>
<td>$156 (152,161)</td>
<td>$570 (540, 602)</td>
</tr>
</tbody>
</table>


The problem of expensive emergency department care is exacerbated by the fact that sometimes there is nowhere else to turn for care in the event of a medical emergency, making the ED is the only option. Costs are often not known in advance, nor is insurance coverage always understood prior to the ED visit. The trend of “surprise medical bills” or “balance billing” has been described by the popular press (Sanger-Katz & Abelson, 2016). This phenomenon occurs when patients visit an ED that is covered by their insurance, but the emergency physician who provided care is not in-network, resulting
in larger than expected medical bills due to the out-of-network billing rates not-in-network physicians charge (Rosenthal, 2014). Many individuals and families cannot afford major, unexpected out-of-pocket expenditures. Data from the Federal Reserve Bank show that 47% of Americans could not pay for a $400 unexpected expense without borrowing money or liquidating assets (Board of Governors of the Federal Reserve System, 2016). As a result, the Consumer Financial Protection Bureau has found that 43 million Americans with consumer credit reports have medical debt. Furthermore, approximately half of debt in collections that appears of credit reports is reported by debt collectors collecting on medical debt (Consumer Financial Protection Bureau, 2014a, 2014b). The majority of these collections are going to hospitals and health care providers (Consumer Financial Protection Bureau, 2014b). Often this debt is catastrophic, leading to personal bankruptcy. Given that the average cost of an ED visit was $1354 in 2011, a 240% increase from 2003, and that 47% of people do not have liquid assets to cover a $400 surprise expenditure, it is easy to see how an ED visit, and certainly a subsequent inpatient hospital stay, can wreak havoc on individuals’ financial solvency (Board of Governors of the Federal Reserve System, 2016; Schuur et al., 2014; Venkatesh & Schuur, 2013). This issue is further complicated by the increase in high deductible health plans that effectively leave many people uninsured, or at least underinsured, when they cannot afford their deductible.

Hospital and emergency department expenditure are of chief concern to insurers and policy makers alike. The negative effects on consumers, hospitals and healthcare providers, and insurers are great and unsustainable. This demonstrates the need for transformative change in our health care system. Given the high-cost environment of the ED, and the sustained cost growth rates, cost-reduction strategies are at the forefront of many minds looking to reduce ED expenditures. Unnecessary utilization of the ED is heralded as one of the major sources of waste in the health care system (Baker & Baker, 1994; PricewaterhouseCoopers, 2010; Richardson & Hwang, 2001). PricewaterhouseCoopers (2010) (PWC) estimates that approximately $14 billion is spent on unnecessary ED visits, annually. As discussed
previously, definitions of unnecessary ED utilization vary substantially. The PWC estimate includes all ED visits reported in NHAMCS as “nonurgent”, which is the lowest triage level of concern. Some experts consider it a questionable practice to assume all “nonurgent” categorized visits are unnecessary ED visits (Honigman, Wiler, Rooks, & Ginde, 2013). In the Honigman et al. (2013) analysis, some ED visitors categorized as “nonurgent” were subsequently admitted to the hospital, including critical care settings. Furthermore, if an individual does not have access to alternative health care (such as a primary care physician) the emergency department may be the only place where he or she can be seen in a reasonable amount of time. It should be noted that some experts have demonstrated that rerouting ED cases to lower cost environments may not result in the cost-savings policy-makers are hoping for (Smulowitz, Honigman, & Landon, 2013).

Despite numerous policy attempts to reform health care and address the increasing costs, opportunity for improvement still exists. Proper ED utilization is an issue that has received a plethora of attention over the years. As early as 1980, publications categorizing ED visits by level of urgency were published. It seems this literature stemmed from the realization in the 1970s that healthcare costs were beginning to increase at unsustainable rates, and expensive emergency department care was immediately targeted (Richardson & Hwang, 2001). The belief then, as it is now, is that if the most expensive types of healthcare can be reduced, then overall health care spending can be reduced; essentially picking the low-hanging fruit. Since then, much effort has been put forth to determine algorithms to define proper and improper ED utilization (Ballard et al., 2010; Billings, Parikh, & Mijanovich, 2000b; Richardson & Hwang, 2001), although there is no universal agreement on what specifically defines proper or improper ED utilization (Richardson & Hwang, 2001). Figure 1, from Richardson and Hwang (2001) illustrates how vastly different estimates of nonurgent emergency department visits were published—all in a seven year span.
Reducing unnecessary ED utilization is being targeted as an effective means to reduce overall health care expenditures. Given the breadth of medical training emergency medicine physicians receive, EDs are able to treat a variety of conditions that are often above and beyond the original intentions to treat accidents, traumas, and major medical emergencies. This allows for EDs to potentially be used for conditions that could be treated equally well in other health care settings at much lower costs (for example, a primary care physician office). Indeed, evidence shows that EDs are often used to treat conditions that could have been treated equally well in an outpatient physician’s office. Garcia, Bernstein, & Bush, 2010; Hoot & Aronsky, 2008; Weinick, Burns, & Mehrotra, 2010). Weinick et al. (2010) demonstrate that between 13.7-27.1% of all emergency department visits could be treated at an alternative outpatient site. The authors estimate that this would save $4.4 billion annually (Weinick et
al., 2010). Treating these types of health care problems in the ED, often called primary care sensitive conditions, are of concern to hospital administrators and health policy advocates alike because of the potential for cost-savings as well as emergency resource shortages for true emergencies, and the impact on health expenditures. The primary problem with reducing this type of wasteful utilization is in its identification strategy. Some have focused on identifying specific discharge diagnosis codes that should not have been treated in the ED. This practice is problematic as the discharge diagnosis codes are not known until a visit concludes. Thus, a common example seen in EDs, is a patient presenting to the ED for chest pain (a potential symptom of myocardial infarction). This patient could end up with a primary discharge diagnosis of acid reflux if it is determined that the source of the chest pain is not a myocardial infarction, but rather, a reflux of acid in the esophagus (Rao, 2011). In hindsight, presenting to the ED for acid reflux seems wasteful, but on the front end, or prospectively, presenting to the ED for chest pain is very appropriate. The problem is that the cause of the chest pain cannot be determined until after the patient is examined in the ED. For this reason, determining whether or not ED care was unnecessary based on the discharging diagnosis code has been deemed an ineffective practice (Raven, Lowe, Maselli, & Hsia, 2013). Time of day may also be a confounder in the determination of what is unnecessary or wasteful ED care. While a condition may be typically thought of as primary care sensitive, if it is occurring at a time of day or night when there is no access to a primary care physician, using the emergency department may be the only viable way to get relief.

Triage scales, which were developed to help ED staff determine a patients’ level of urgency (Farrohknia et al., 2011), have been suggested as one solution for identifying unnecessary ED visits, although this was not the original intent of triage scales. One troubling feature of triage scales is that they have not historically been standardized, nor is implementation always consistent across organizations, making longitudinal and/ or cross-institutional, comparisons unreliable (Gilboy, Tanabe, Travers, & Rosenau, 2011). In more recent times, the Emergency Severity Index (ESI) has been used to
triage patients based on their clinical status and expected resource utilization. However, in practice, the ESI scale is not always implemented with fidelity, again, making longitudinal and/or cross-institutional comparisons less reliable.

The National Hospital Ambulatory Medical Care Survey (NHAMCS) uses a standardized categorization of patient acuity that is based on how quickly it is believed a patient needs to be seen by a physician. The 2006 NHAMCS data shows that 22.0% of patients were triaged as semi-urgent (should be seen in 61-120 minutes), and 12.1% were triaged as nonurgent (should be seen in 120 minutes-24 hours) which the authors stated was similar to the previous year’s (2005) data (Pitts, Niska, Xu, & Burt, 2008). The 2011 report showed an increase in semi-urgent patients (35.5%) and a decrease in nonurgent patients (8.0%). The practice of categorizing patients into these discrete categories also improved over the time period from 2006-2011, with 12.1% of patients not being categorized in 2006 and only 2.2% of patients not being categorized in 2011 (National Center for Health Statistics, 2016). While there was an increase in semi-urgent patients over the time period, it is not known if this was due to changes in patient behavior, categorization practices, care provided by pre-hospital providers (for example, paramedics), or population health improvements.

Evidence is mixed, but limited, on whether or not using the ED for nonurgent health problems is truly a poor use of monetary resources. In an analysis of fixed, variable, and marginal emergency department costs, Williams (1996) found that the marginal cost of a nonurgent ED visit was approximately $88. While this figure appears low, there is no comparison figure for outpatient primary care, so it is unknown how this amount compares to other care environments. A more recent analysis that uses a more advanced econometric technique for measuring marginal cost (compared to Williams (1996)), demonstrates that a marginal visit to a non-trauma ED costs $300 and a visit to a trauma ED costs $400, on average (Bamezai, Melnick, & Nawathe, 2005). The Bamezai et al. (2005) analysis and subsequent correspondence by Florence (2005) assert that the data suggests that most of the EDs costs
are due to variable costs (staff), rather than fixed costs (building and equipment). Florence (2005) explicitly states that the Bamezai et al. (2005) analysis should be considered superior to the Williams (1996) due to a larger sample size conducted over a longer period of time, and a superior statistical methodology. While perhaps not methodologically superior, Williams (1996) still makes a relevant point: a nonurgent visit to a primary care office on a weekday at 4pm likely has a low marginal cost, but a marginal visit at 4am would have a very high cost for primary care offices that do not operate 24 hours per day. Williams is essentially arguing that the economics of scale make it more reasonable for EDs to treat minor cases, rather than opening up additional outpatient (less expensive) capacity to treat additional minor volume at all hours of the day and night. For this reason, some experts argue that shifting nonurgent ED care out of the ED will not have a big impact on overall healthcare expenditures (Smulowitz et al., 2013; Williams, 1996) which goes against the longstanding belief that rerouting minor care from the ED will have a cost-savings effect (McWilliams & Schwartz, 2017; Merritt, Naamon, & Morris, 2000; New England Healthcare Initiative, 2010). The Bamezai et al. (2005) analysis discredits this to some extent since economies of scale were not detected (average total costs for ED visits were not found to decrease as additional visits occurred). This should not be surprising, since, as the number of ED visits increases on a given day, additional staff is often called in (and visa versa), thus increasing costs when volumes are high and decreasing costs when volumes are low, subsequently keeping average costs relatively consistent (Bamezai et al., 2005). Fixed costs for EDs may be high, but the majority of costs are variable and easily flexed, thus wiping out any ability to generate substantial savings by having higher volumes. While the ability to fluctuate staffing levels may be easier in hospitals than small private primary care offices, it does suggest that the economies of scale argument may not be as robust as some have suggested. Overall, there is still an argument to be made for trying to divert care for primary care sensitive conditions away from EDs and into more appropriate settings like urgent care, primary care offices or retail clinics, but this argument is not iron-clad.
The dissent around the issue of rerouting nonemergent care away from EDs typically takes two forms—disputes about whether or not economies of scale exist, as described above, and (more commonly) the amount of minor care that is truly delivered in EDs. The majority of analyses of emergency department visit urgency are based on discharge diagnosis codes. However, the diagnosis is not known until the patient is seen, thus the patient could be presenting with a chief compliant of something seemingly emergency, only to be discharged with something less emergent (Duncan, 2010). Thus, estimates of rates of nonemergent conditions seen in EDs are sometimes discredited on this basis. Data has shown that there is a lack of concordance between chief complaints (what the patient states their medical problem is at ED arrival) and discharge diagnoses (the official diagnosis, after medical examination and treatment) (Raven et al., 2013). Furthermore, even among those with similar chief complaint and discharge diagnosis that fall under the primary-care sensitive definition, some cases still require immediate emergency care or hospital admission, further questioning the accuracy of the algorithms used to identify unnecessary ED visits (Raven et al., 2013). Additionally, policies and interventions that seek to reroute or reduce ED care sometimes have negative unintended consequences, such as causing people to delay needed ED care, or increasing utilization of urgent care or retail clinics by people who would have otherwise stayed home (Uscher-Pines, Pines, Kellermann, Gillen, & Mehrotra, 2013). Thus, it is possible that simply rerouting nonemergent care away from EDs may be not be as easy, or as effective as it seems on the surface.

While opinion is not settled on whether or not nonurgent ED visits should be rerouted to other levels of care on the basis of cost, the evidence clearly demonstrates that conditions are ripe for shortages of emergency medicine resources. This problem alone may necessitate a revitalization of ongoing efforts to reroute nonemergent patients away from EDs to preserve emergency resources for patients experiencing true medical emergencies. Shortages are a true concern for health care users and policy-makers alike. A shortage of emergency medicine resources is worrisome because it could lead to
people not receiving needed emergency care, which, in a worst case scenario, could lead to increased preventable mortality or morbidity. Evidence suggests that market conditions for a shortage are present. The number of EDs have decreased as ED visits have simultaneously increased (American Hospital Association, 2016; Hsia et al., 2011; Rabin, 2011; Tang et al., 2010). The simultaneous increase in demand for ED-care and decrease in supply of EDs is of concern because of the potential for market inefficiencies (primarily shortages). Hsia et al. (2011) reported that from 1990 to 2009 1,041 EDs closed and 374 hospitals opened EDs—resulting in a net decrease in EDs. More recent data from the American Hospital Association shows the that this trend has continued to persist into 2014, as seen in Figure 2 below (American Hospital Association, 2016). Emergency departments located in counties serving primarily impoverished patients were more likely to close than those serving relatively wealthier populations (Hsia et al., 2011; Shen et al., 2009). Furthermore, while freestanding emergency departments have become more common (Gutierrez, Lindor, Baker, Cutler, & Schuur, 2016), they are more frequently placed in areas with better payer mixes (Schuur et al., 2016)—thus increasing the supply of emergency resources available to the wealthy. This inequitable distribution of emergency care worsens already existing health disparities experienced by low-income individuals. The closure of an ED becomes especially problematic for individuals who do not live close to alternative EDs, such as those in rural areas. Increased drive times to EDs have been shown to negatively impact survival rates for acute time-sensitive health problems like heart attacks and strokes (Liu et al., 2014).
Source: American Hospital Association, Chartbook (2016). Permission to reprint granted by AHA.

In short, overall, emergency departments provide a unique and necessary health care service in the United States. The ED is a safety-net provider, providing care for patients regardless of ability to pay. For patients without established primary care connections, or those otherwise unwilling or unable to use primary care providers, the emergency department serves as a usual source of care for a segment of the population, making it a critical element in the public health support infrastructure. As the profession and market for emergency medical treatment has evolved, the way in which the total population uses the emergency department has begun to come under scrutiny, especially given the high costs of emergency medical care. A movement to reduce “improper” ED utilization (which has yet to be defined in a way that is agreeable to all involved parties) has been on-going in light of the need to slow the
growth of medical expenditures. Some argue that no primary care sensitive conditions (PCSCs) should be treated in the emergency department because doing such ties up resources that should be reserved for those having true medical emergencies. Others argue that these PCSCs need to be offered as a service because the ED is still a “provider of last resort” to many. And yet others cannot agree on what even defines a PCSC. A balance needs to be found where emergency medical care can be easily accessible to those with true emergencies, but not too accessible so as to attract a multitude of patients with healthcare problems that could be treated in other, generally lower cost, environments. Solving these problems in an optimal way will lead to reduced healthcare expenditures while preserving equitable access to health care for those who do not have access to physicians in private practice. There may not be one magic strategy that reduces health care expenditures overall, or even in the ED alone; rather, it will likely require numerous strategies and policies to reduce health care expenditures. One such strategy is focusing on high utilizing patient populations, such as ED frequent users.

**Focusing on Frequent Users**

As policy makers and hospital administrators have evaluated ways to reduce or re-route emergency department utilization—or otherwise free-up ED resources—the topic of emergency department frequent users often arises. Emergency department frequent users are often targeted as a means to reduce waste in the healthcare system because they use an expensive resource, the ED, with high frequency. The standard literature definition of an ED frequent user is a person who makes four or more emergency department visits in a 12-month period (Byrne et al., 2003; Grover & Close, 2009; Hunt, Weber, Showstack, Colby, & Callaham, 2006; Ledoux & Minner, 2006; Locker, Baston, Mason, & Nicholl, 2007). While no national cost estimate of ED frequent users exists, data from South Carolina indicates that the average total cost per ED frequent user is over 15 times greater than the average cost of a non-frequent ED user, demonstrating the high costs these patients accrue (South Carolina Public Health Institute, 2011).
This population is relatively easy to identify using administrative datasets or electronic medical records. Some electronic medical records for emergency departments have notification flags built in to identify frequent users when they present the emergency department to alert health care providers (Cantlupe, 2013). It is believed that, if given effective interventions to reduce ED utilization, significant reductions in health care expenditures can be realized. In terms of reducing health care utilization, ED frequent users are an opportunity that is more-easily obtained than alternatives (for example, low-hanging fruit). This relatively small group of people makes a significant portion of ED visits, and subsequently generates substantial expenditures. In a systematic review, LaCalle and Rabin (2010) reported that frequent ED users make 21-28% of annual ED visits, but account for only 4.5-8% of the ED-using population, illustrating how a small group of people utilize a relatively large share of resources. In addition to using more ED resources, ED frequent users also use a disproportionate amount of monetary resources. Handel, McConnell, Wallace, and Gallia (2008) report that 50% of all ED expenditures for the Oregon Medicaid program are attributed to just 3% of Oregon’s Medicaid beneficiaries, all of whom were ED frequent users.

Some interventions have been shown to effectively reduce reliance on ED resources among ED frequent users (Althaus et al., 2011; Kumar & Klein, 2013; Shumway, Boccellari, O’Brien, & Okin, 2008). The vast majority of the interventions for ED frequent users have been focused on case management activities (Althaus et al., 2011; Bodenmann et al., 2014; Dattalo et al., 2014; Kumar & Klein, 2013; Okin et al., 2000; Pope, Fernandes, Bouthillette, & Etherington, 2000). In a systematic review of literature on case management interventions for ED frequent users, Kumar and Klein (2013) found that, of the 11 studies that used ED utilization as a primary outcome metric, 8 out of 11 studies detected significant reductions in ED utilization after the care management intervention. However, no studies were able to show a reduction in health expenditures (Kumar & Klein, 2013), indicating that ED frequent user interventions still have room for improvement. In general these studies are small interventions run by
one hospital or physician office, have small sample sizes, and are frequently evaluated as pre-post cohort studies where subjects serve as their own controls, rather than randomized controlled trials. Evidence suggests that the majority of ED frequent users only use the ED with high frequency for a short period of (usually a few months)—thus their frequent use resolves naturally—without intervention (Johnson et al., 2015). For this reason, the results of the cohort studies examining ED frequent user interventions have been called into question. Randomized controlled trials have generally not replicated the success observed in observational studies (Soril, Leggett, Lorenzetti, Noseworthy, & Clement, 2015).

Theoretical Foundations

Typically in ED frequent user interventions, ED frequent users are targeted as a universal group with an intervention. Literature from psychology and the behavioral health sciences indicate that targeting health care interventions to the unique characteristics of people is more effective than universally targeting large heterogeneous groups of people (Kreuter, Lukwago, Bucholtz, Clark, & Sanders-Thompson, 2002; Lairson, Chan, Chang, del Junco, & Vernon, 2011; Meropol et al., 2014). To clarify, targeting in this context is defined as “the process of identifying a population subgroup (defined by parameters relevant to health promotion goals and objectives) for the purpose of insuring exposure to the intervention by that group” (Pasick, D’Onofrio, & Otero-Sabogal, 1996). This differs from the traditional marketing definition of targeting that refers to audience segmentation for the purpose of generating sales. In this public health context, targeting is focused on making sure the intervention is being delivered to the intended population.

The concept of tailoring, similar to targeting, is an important concept with respect to interventions for ED frequent users. While targeting an intervention refers to the practice of delivering resources to the intended patients, tailoring refers to making the intervention fit the unique needs of those who have been targeted to receive the intervention. A tailored intervention will have specific strategies geared towards meeting the unique needs of the population selected to receive the
intervention or communication (Rimer & Kreuter, 2006). Interventions can be tailored to reflect a variety of characteristics including disease type, income level, or race/ethnicity (Kreuter et al., 2002). One common practice of tailoring is making interventions culturally appropriate (Kreuter et al., 2002). In practice, both targeting and tailoring can work together to support optimal performance. However, to get to the point where an intervention can be tailored to a targeted group of individuals, subgroups of individuals needs to be created, and the group characteristics need to be understood.

Christensen (2000) argues that patients need to be broken into sub-groups based on individual characteristics because individual characteristics may interact with the ability of people to adhere to health regimens, thus impacting the health outcome. Data have shown that patients who had a strong preference for active involvement in their own health care who received treatment from very staff-directed hemodialysis program tended to have worse adherence scores than patients with strong involvement preferences who were treated at home in a more patient-directed setting (Christensen, 2000). A person’s cultural traditions (such as dietary preferences like high sodium diets) can also impact health behaviors (such as cooking high sodium foods) that can cause adverse health outcomes (for example, high blood pressure). Thus, if a group of patients have a commonality, such as high sodium diets, this element will negatively affect their ability to adhere to health regimens that require adhering to lower sodium diets, and may have a subsequently negative effect on health outcomes. In this case, the intervention would need to be tailored to reflect the dietary culture among this subgroup of patients.

Theories of health behaviors have established the precedent for personal characteristics influencing health behaviors and thus health outcomes. The health belief model postulates that the strength of an individual’s belief in the perceived threat of a negative outcome occurring as a result of the health behavior being targeted is key to changing the health behavior (Janz & Becker, 1984). Thus if a diabetic individual believes that having uncontrolled blood glucose will result in neuropathy and
blindness, but that if they take their medications as prescribed they will be able to control their blood glucose—they will be more likely to take their medications as prescribed. The individual needs to believe that the problem (uncontrolled blood glucose) causes the health problem (neuropathy, blindness), and that the health behavior (taking medications as prescribed) will mitigate the problem (uncontrolled blood glucose).

Similar to Christensen, Bandura’s Social Cognitive Theory posits that behavior is the result of interactions between personal characteristics, one’s environment, and the health behavior in question (Bandura, 1986). Thus, if someone is uninsured and lives in a place with very few primary care providers— they may be more inclined to use the emergency department than someone with insurance who lives very close to their established primary care physician. Social cognitive theory asserts that behaviors occur as a result of a many factors, rather than just one. Understanding the multitude of factors that drive the health behaviors are especially important for public health professionals to understand. These factors, which may be personal characteristics or other environmental or social factors, will be important to address if behavior change is being sought. An understanding of the factors that drive health behaviors helps public health professionals understand what factors need to be targeted with interventions. Strecher, Wang, Derry, Wildenhaus, and Johnson (2002) write that tailored interventions require knowledge of individual level characteristics to effectively influence targeted individuals. Thus, without knowledge of patient level characteristics, effective tailoring may not be able to occur. This provides further support for the idea that personal characteristics (and other factors) need to be taken into account when designing interventions to address health behaviors.

The concept of self-efficacy is defined as an individual’s belief that they possess the ability to perform the health behavior, and that its performance will lead to the desired outcome (Bandura, 1986). Self-efficacy can also be regarded as an individual’s belief in what they can accomplish given their skills (Snyder & Lopez, 2007). When self-efficacy is high, adherence to the behavior is high, and visa versa.
Said another way, if individuals believe they can be effective at a particular behavior, then their motivation to perform the behavior is increased, as is the likelihood of the performance of the behavior (Bandura, 1982). In practice, this means that interventions aimed at changing health behaviors must address self-efficacy or individual’s confidence in their own capacity to perform the behavior. Different individuals will have different barriers to being able to perform health behaviors- so interventions subsequently need to tailor themselves to these unique needs. In the heterogeneous population of ED frequent users, it is likely that people will have different barriers to performing health behaviors. Thus, an intervention that targets only one barrier will likely not be effective for the entire group of ED frequent users.

Self-regulation is another concept described by Bandura (1991, 2005) that describes how individuals regulate their behaviors to set and reach goals. Self-efficacy is a major determinant of self-regulation. In fact, self-efficacy influences two of the three self-regulative mechanisms (self-monitoring and judgment of one’s behavior (Bandura, 1991). Self-regulation is necessary to changing behavior, but self-efficacy is required before self-regulation so that subsequent behavior change can occur. The last self-regulative mechanism, environmental factors, is also important to note as these factors can often be addressed by tailored interventions. In real-life applied intervention work, understanding the factors that contribute to or detract from self-efficacy and self-regulation will influence the ability (and likelihood) of an individual to perform the desired health behavior, thus indirectly influencing the desired health outcome. Doing this requires a strong understanding of patient characteristics as well as environmental and social factors.

In practice, it has been established that targeted and tailored interventions addressing the unique aspects of the population, or the environment in which the population resides, are more effective than non-targeted and non-tailored interventions (Fisher & Fisher, 1992; Glanz, Rimer, & Lewis, 2002; Kroeze, Werkman, & Brug, 2006; Meropol et al., 2014; Noar, Benac, & Harris, 2007). In a meta-
analysis regarding interventions aimed at reducing new cases of HIV/AIDS, Fisher and Fisher (1992) stated “that formal elicitation research to identify group-appropriate intervention tactics is rare”, meaning that sub-groups were rarely identified before leveraging an intervention. However, when such research and identification is performed, intervention effectiveness increased (Fisher & Fisher, 1992). Fisher and Fisher (1992) suggest that some HIV/AIDS prevention interventions were developed and implemented before fully understanding the population whom the interventions were intended to serve (for example, sub-groups were not identified) which potentially decreased the effectiveness of the intervention. When interventions are performed on groups of people that are not well-understood, intervention effectiveness is not maximized, thus wasting limited resources for public health interventions.

This same problem appears to be present in the practice of creating interventions for ED frequent users, which could explain why utilization and expenditure problems still persist, despite decades spent trying to solve the problem of ED frequent users. This may help explain why so few randomized controlled trials of ED frequent user interventions show positive results with respect to reduced ED and inpatient utilization, and health care costs (Althaus et al., 2011). While many pre-post studies (with no control group) have demonstrated ED visit reduction (Althaus et al., 2011), it is believed that this reduction in visits would have occurred anyway since very few ED frequent users maintain their high utilization for extended periods of time (Johnson et al., 2015). One study conducted by members of the Camden Coalition, a group focused on high-utilizing patient populations, tested the effectiveness of a diabetes self-management program targeted to diabetics. This intervention was found to not be effective, and the authors stated that further targeting of the intervention to specific subgroups of patients within the population of diabetics would be needed to effectively reduce health care costs among the population, in addition to more tailoring of the intervention itself to reflect the needs of the
population (Burton et al., 2016). This reflects the need to both target and tailor interventions for high-need patients.

Few attempts have been made to create meaningful subgroups of ED frequent users. Of those attempted, most are visit-based (Billings & Raven, 2013; Ruger et al., 2004) or disease-based (Johnson et al., 2015). These groupings simply use a dataset to divide ED frequent users into groups based on the number of ED visits they make in a finite time period (typically a year), or into groups based on a clinical diagnosis (typically from an administrative database where diagnosis codes are optimized for billing, rather than clinical significance). These groups are only meaningful if within group characteristics are homogeneous enough for an intervention to be easily targeted and tailored to the subgroups. Furthermore, these attempts to group ED frequent users assumes that the number of visits or disease-type is either the reason for—or is strongly related to the underlying reason why—ED frequent users have high utilization. If it is the case that there is another reason, a latent reason, for why this population has high ED utilization, then these groupings will not be the most efficient way to define (and subsequently target) this population.

Other attempts have been made to define and target patient groups with high utilization of ED and inpatient resources called “super-utilizers”, and to provide interventions for those subgroups. Super-utilizers are those who use inpatient resources with extreme frequency (typically 3 or more admissions per year) in addition to high ED utilization (Johnson et al., 2015). Some interventions have targeted Medicaid super-utilizer patients and tailored the intervention to fit the needs of low-income individuals (Bodenheimer, 2013). Other analyses have used a priori subgroupings based on disease or utilization status, as in Johnson et al. (2015). The Camden Coalition of Healthcare Providers (2014) use a more sophisticated methodology that first segments the population, then identifies appropriate interventions. Like others who have studied high utilizing populations, the Camden group determined that super-utilizers were a heterogeneous population, and needed to find structure within the data on
their patient population so they could understand the similarities and differences between patients. Using cluster analysis with two variables, the number of ED visits and the total cost of ED and inpatient care, they were able to segment their population into homogeneous groups. The Camden-style employment of this methodology creates a graphical plot of patients on a plane (Camden Coalition of Healthcare Providers, 2014, 2015). The plot is then visually examined to determine if clusters of patients exist as demonstrated in Figure 3. Patient characteristics of the identified groups are then examined (outside of ED visits and total inpatient costs) to decipher differences between groups and similarities within groups. This method assumes that the number of ED visits and total inpatient costs drive the differences between groups, rather than examining correlations between multiple variables, as in is possible with other methodologies, including Latent Class Analysis. Furthermore, model selection in cluster analysis is largely subjective with respect to determining the number of groups with limited guidance or rules existing for selecting the number of clusters in classical cluster analysis models (Cheong & Lee, 2008). While the Camden group does not employ this methodology, Euclidian distances can be used to determine which members are included in each pre-specified group, once the number of models is determined (Kuhn & Culhane, 1998). This method introduces more objectivity, but the determination of the number of classes is still largely subjective.
Figure 3: Camden Coalition of Healthcare Providers Cluster Analysis Plot

Source: Camden Coalition of Healthcare Providers. Permission granted. The image is for illustrative purposes only and does not represent the full distribution of hospital utilization in Camden or all clusters observable in the data.

After segmentation, interventions are then tailored to the specific needs of the identified subgroups (Camden Coalition of Healthcare Providers, 2014). A benefit of using cluster analysis instead of classifying patients into groups based on a singular a priori defined category (as in Johnson et al. (2015) is that cluster analysis allows one to consider multiple dimensions (or variables). However, the population graph-based cluster analysis that the Camden Coalition utilizes uses only two variables (ED visits and costs). While no explanation for why only two variables were used, it should be noted that analyzing more than 2 dimensions graphically is significantly more complicated. Furthermore, in addition to the methodological critiques noted above, this analysis is difficult to generalize to other populations beyond Camden since the clusters are not well-defined with specific conditions. Rather, the descriptions of the population are relative, “high-cost, high-utilizing” patients and “medium-cost, medium-utilizing” patients. It would be difficult for outside institutions to group their patient populations into these
categories and then try to tailor interventions to the identified population while knowing so little about the identified population. Furthermore, geographic variation in the cost of healthcare may also impact the generalizeability of these results, since the cost of procedures varies substantially across the country (Fisher et al., 2003). This method almost necessitates each institution performing its own cluster analysis, and developing its own set of interventions—which may not be feasible for all institutions without support from statisticians or other researchers.

Interventions aimed at improving the health and wellness of high-utilizing populations are often motivated by financial concerns. Since these patients are often high-cost individuals, the incentive to intervene is heightened compared to other less-costly patients who may also be sick. Highly targeted interventions have better financial outcomes through two avenues. First, superior financial performance is achieved by providing the right resources to the right people, which improves financial outcomes by reducing the cost inputs of the intervention (by not spending money on unnecessary resources) (King, Ahn, Atienza, & Kraemer, 2008). In Owens et al. (2003) certain patient or environmental characteristics were found to modify the effect of specific components of the interventions on the outcome (making the intervention ineffective in producing the outcome). Thus, it would not be wise to invest resources into providing these components to those specific individuals with the characteristics known to mitigate the effect of the intervention on the outcome. Second, financial outcomes have been shown to be better in targeted interventions by simply having increased effectiveness, or more “bang for the buck” (Noar et al., 2007; Wu, Fung, Chan, & Lairson, 2004). Additionally, targeted interventions have demonstrated greater effectiveness than universally delivered interventions (Aspinall et al., 2015; Clarke, Hawkins, Murphy, & Sheeber, 1993; Clarke et al., 1995). Theoretically downstream costs could potentially be lower among high-utilizing patients who successfully changed healthcare consumption through an intervention; however, this remains a hypothetical as peer-reviewed literature has not
demonstrated evidence of this. Some evidence in the lay press has suggested long-term financial benefits (Maron, 2014).

Before financial gains or increased health can be realized through targeted and tailored interventions, sub-groups of frequent ED users need to be more firmly established. Once homogeneous sub-groups are established, sub-groups can be targeted with interventions that are tailored to meet their specific needs. Without understanding the characteristics or commonalities of patients within sub-groups, effective tailoring cannot occur. However, with proper targeting and well-tailored interventions, improved health and improved financial metrics can occur. At present, there are no established sub-groups of ED frequent users, despite calls from the literature for such a typology (Pines et al., 2011). The Camden Coalition work comes close, but this work is focused on the broader category of high-utilization patients (outside of just the emergency department). Given the lack of established typology, interventions typically target the entire population of ED frequent users (as defined by a certain number of ED visits per year, or perhaps a disease category). In order to best utilize resources, ED frequent user interventions should be targeted to the appropriate group of people and tailored to their unique needs to ensure maximal effectiveness (Johnson et al., 2015; Krieg, Hudon, Chouinard, & Dufour, 2016). This practice is consistent with literature from evaluation science that targeted and/or tailored interventions are more effective than general, universally delivered interventions (Kreuter et al., 2002; Meropol et al., 2014; Rimer & Kreuter, 2006; Strecher et al., 2002). Furthermore, when a health system or other institution decides which group of patients to target, it can be beneficial to take into consideration which sub-group of patients is most costly, to optimize cost-avoidance. If the health system can target the group that costs the most, and improve their health and reduce their utilization overtime, cost-savings can be generated that can potentially be re-invested in additional health care providing activities.
Research Questions

Rather than universally targeting the entire population of ED frequent users, sub-groups can be targeted with interventions that address their unique characteristics that can potentially influence health behaviors and the resulting outcomes, as described by Bandura (1999). In order to one day develop targeted interventions, the presence of homogeneous sub-groups needs to be evaluated within the frequent ED user population.

The primary research question in this analysis asks if there are homogeneous sub-groups within the ED frequent user population. In the event that there are homogeneous sub-groups that can be identified, the second research question asks for a description of the characteristics of the sub-groups. Lastly, the third research question asks which sub-group is the highest cost group.

The purpose of this analysis is to define subgroups of ED frequent users and determine which group would be associated with the greatest cost-savings if provided an effective intervention. This study has three aims.

1. To define subgroups of ED frequent users with homogeneous characteristics
2. To examine how demographic characteristics are associated with sub-group membership
3. To develop a recommendation as to which group, if given an effective intervention, would offer the greatest cost-avoidance advantage

Developing a typology of ED frequent users will help those developing and implementing interventions to improve the health of this population, and reduce their health care utilization (Johnson et al., 2015; LaCalle & Rabin, 2010).
Chapter 2: Review of Literature

While there are no well-defined or commonly agreed upon subpopulations of ED frequent users, to date, although there have been a number of attempts to distinguish ED users to better understand utilization. For example, an analysis by Billings and Raven (2013) showed the following breakdown of characteristics of ED visitors by different levels of ED visits made in one year (Table 2). This analysis was based on data from New York City Medicaid beneficiaries. As evidenced by the data, those Medicaid beneficiaries who make 15 or more ED visits are more likely to have a mental health or substance use disorder than are those who only make 3-4 visits per year. As the number of ED visits made in a year increases, the percent of people with a chronic condition also increases. Thus, those people who use the ED with the highest frequency tend to be the most medically complex, in terms of chronic disease. The implications of this can be longer wait times (as these patients require more intense work-ups), increased testing and/or procedures (increasing both time and costs), as well as the potential for a greater need for specialty physician consultations during the ED visit or referrals to specialists at discharge. Those with the highest levels of ED visits have rates of eligibility for disability that are nearly twice as high as those with only 3-4 visits per year. The highest level of ED users were among the least likely to be enrolled in a managed care plan.
Table 2: Characteristics and Usage of Medicaid-insured ED users by the number of Annual ED visits

<table>
<thead>
<tr>
<th>Number of ED visits</th>
<th>1</th>
<th>2</th>
<th>3-4</th>
<th>5-6</th>
<th>7-9</th>
<th>10-14</th>
<th>15+</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>100,556</td>
<td>50,144</td>
<td>35,652</td>
<td>12,529</td>
<td>5,653</td>
<td>2,438</td>
<td>1,287</td>
<td>212,259</td>
</tr>
<tr>
<td>Percent of patients</td>
<td>47.4</td>
<td>23.6</td>
<td>18.7</td>
<td>5.9</td>
<td>2.7</td>
<td>1.1</td>
<td>0.6</td>
<td>100</td>
</tr>
<tr>
<td>Percent of ED visits</td>
<td>113</td>
<td>198</td>
<td>26.2</td>
<td>133</td>
<td>86.6</td>
<td>55.5</td>
<td>68.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Demographic Characteristics**

- Mean age (years): 36.5, 36.4, 36.1, 36.1, 36.5, 37.7, 41.3, 36.4
- Percent female: 68.8, 69.1, 71.6, 70.7, 68.2, 60.8, 41.3, 67.8

**Insurance Coverage (%)**

- Disabled eligibility*: 18.6, 23.3, 22.4, 32.8, 37.1, 42.1, 53.4, 33.2
- In managed care: 96.3, 55.0, 55.1, 52.5, 48.2, 41.7, 28.5, 55.2

**History of Chronic Conditions**

- Any chronic condition: 45.5%, 50.2%, 55.1%, 61.2%, 66.9%, 73.9%, 84.5%, 50.9%
- Number of chronic conditions: 0.0%, 0.5%, 1.0%, 1.2%, 1.5%, 1.7%, 2.3%, 0.9%
- Multiple chronic conditions: 21.2%, 24.7%, 28.2%, 33.9%, 39.0%, 41.6%, 63.0%, 25.1%
- Substance use: 17.4, 22.1, 22.7, 35.0, 43.0, 55.5, 73.3, 33.0
- Mental illness: 28.4, 34.9, 41.3, 49.2, 57.6, 65.3, 78.0, 35.1
- Schizophrenia: 5.0, 6.5, 7.0, 12.6, 16.1, 23.1, 33.6, 7.3
- Bipolar disorder: 4.4, 6.3, 5.0, 12.8, 17.4, 23.5, 31.0, 7.0
- Depressive psychosis: 8.8, 11.2, 14.7, 18.0, 21.6, 25.8, 34.5, 11.8
- Substance use or mental illness: 30.0, 43.0, 50.0%, 58.8, 67.8, 77.4, 90.2, 43.6
- Substance use and mental illness: 9.0, 13.6, 18.2, 25.4, 35.6, 43.3, 62.0, 14.5
- Charlson index*: 1.15, 1.29, 1.60, 1.89, 2.19, 2.43, 3.20, 1.39

*Authors' analysis of New York City Medicaid claims and encounter data. More percentages may not sum to 100 because of rounding in both exhibit and text.

Source: Authors' analysis of New York City Medicaid claims and encounter data. More percentages may not sum to 100 because of rounding in both exhibit and text.

A similar analysis was conducted by Ruger et al. (2004) presents key demographics associated with groups identified in this analysis. Unlike the Billings and Raven (2013) analysis, this was a single-hospital data analysis, thus the generalizeability of the results may not be as strong. Ruger et al. (2004) divide the patient population by number of ED visits, however they use a different grouping methodology (1 visit, 2 visits, 3-5 visits, 6-20 visits, and 20 or more visits). The data shows that most groups have similar mean ages, although the highest utilization group (20 or more visits) is the oldest, on average, at 50.7 years of age. The acuity ratings (acuity A-E) are ranked from highest acuity (A) to lowest acuity (E). Those presenting 20 or more times to the ED were significantly more likely to make visits for low acuity reasons (acuity E) (Ruger et al., 2004). Those making 6-20 ED visits per year were most likely to be admitted to an inpatient hospital unit, and those making 20 or more ED visits were least likely to be admitted (Ruger et al., 2004). Another major difference was the percent of people...
discharged against medical advice (AMA) or as an elopement. An AMA discharge means that the patient wanted to leave, even though the physician recommended that they stay in the ED for medical reasons. Patients who are discharged AMA are counseled on the risks leaving against medical advice prior to leaving. An elopement occurs when a patient leaves, but has not been counseled on the risks of leaving. Patients in the highest utilization category were discharged AMA/ Elopement 20.5% of the time—which is a much higher rate than any other category of ED users (Ruger et al., 2004).

Table 3: Demographic Characteristics of ED Users

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 3: Demographic Characteristics of ED Users</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Visit</td>
<td>2 Visits</td>
<td>3–5 Visits</td>
<td>6–20 Visits</td>
<td>&gt;20 Visits</td>
</tr>
<tr>
<td><strong>Patients, n (%)</strong></td>
<td>35,539 (70.7)</td>
<td>8,712 (17.1)</td>
<td>5,237 (10.3)</td>
<td>939 (1.7)</td>
<td>23 (0.05)</td>
</tr>
<tr>
<td><strong>Demographic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age—mean, yr (SD)</strong></td>
<td>42.4 (10.1)</td>
<td>42.7 (8.2)</td>
<td>43.8 (2.7)</td>
<td>43.3 (6.9)</td>
<td>50.7 (7.4)</td>
</tr>
<tr>
<td><strong>Gender—men, n (%)</strong></td>
<td>15,620 (35.5)†</td>
<td>3,382 (38.8)†</td>
<td>1,827 (35.7)†</td>
<td>331 (55.3)†</td>
<td>354 (43.9)</td>
</tr>
<tr>
<td><strong>Visits, n (%)</strong></td>
<td>35,539 (44.8)</td>
<td>17,425 (21.7)</td>
<td>18,547 (23.1)</td>
<td>7,449 (9.3)</td>
<td>849 (1.1)</td>
</tr>
<tr>
<td><strong>Triage level‡</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Acuity A</strong></td>
<td>861 (2.4)§</td>
<td>299 (1.8)</td>
<td>206 (1.2)§</td>
<td>86 (1.2)§</td>
<td>4 (0.5)</td>
</tr>
<tr>
<td><strong>Acuity B</strong></td>
<td>12,815 (35.8)§</td>
<td>6,021 (35.7)§</td>
<td>6,977 (35.9)§</td>
<td>3,215 (44.6)§</td>
<td>290 (35.3)</td>
</tr>
<tr>
<td><strong>Acuity C</strong></td>
<td>16,041 (48.6)§</td>
<td>8,184 (48.5)§</td>
<td>8,287 (46.2)§</td>
<td>3,017 (41.7)§</td>
<td>298 (36.3)</td>
</tr>
<tr>
<td><strong>Acuity D</strong></td>
<td>3,808 (10.9)§</td>
<td>2,072 (12.3)*</td>
<td>2,189 (12.2)*</td>
<td>771 (10.7)</td>
<td>179 (21.8)</td>
</tr>
<tr>
<td><strong>Acuity E</strong></td>
<td>418 (1.2)§</td>
<td>298 (1.8)*</td>
<td>298 (1.6)</td>
<td>140 (1.9)</td>
<td>50 (6.1)§</td>
</tr>
<tr>
<td><strong>Disposition status‡</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>All hospital admit</strong></td>
<td>7,864 (21.9)§</td>
<td>3,090 (22.4)</td>
<td>4,607 (24.8)§</td>
<td>1,994 (26.8)§</td>
<td>83 (9.8)¶</td>
</tr>
<tr>
<td><strong>ICU/OR admit only</strong></td>
<td>806 (2.3)§</td>
<td>297 (1.7)</td>
<td>281 (1.5)§</td>
<td>107 (1.4)¶</td>
<td>3 (0.4)¶</td>
</tr>
<tr>
<td><strong>Died in ED</strong></td>
<td>138 (0.4)§</td>
<td>27 (0.2)¶</td>
<td>23 (0.1)§</td>
<td>10 (0.1)§</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td><strong>Discharged home</strong></td>
<td>25,038 (69.7)§</td>
<td>11,904 (68.3)</td>
<td>12,170 (65.6)§</td>
<td>4,640 (62.3)§</td>
<td>568 (68.9)</td>
</tr>
<tr>
<td><strong>Transfer</strong></td>
<td>242 (0.7)§</td>
<td>100 (0.6)</td>
<td>74 (0.4)¶</td>
<td>26 (0.4)§</td>
<td>1 (0.1)</td>
</tr>
<tr>
<td><strong>Eloped/AMA</strong></td>
<td>247 (0.6)§</td>
<td>1,394 (8.0)</td>
<td>1,568 (8.4)¶</td>
<td>733 (9.8)§</td>
<td>174 (20.5)¶</td>
</tr>
</tbody>
</table>

Percentages may not exactly equal 100% due to rounding, missing data, and exclusion of "other" disposition status category.
* Analysis performed at the patient level.
† Statistically significant at the p < 0.001 level when compared with all other groups combined.
‡ Analysis performed at the visit level.
§ Statistically significant at the p < 0.001 level when compared with all other groups combined, accounting for clustering of visits within patients using logistic regression with Huber-White correction for clustering.
¶ Statistically significant at the p < 0.05 level when compared with other groups combined, accounting for clustering of visits within patients using logistic regression with Huber-White correction for clustering.

As a result of such variability, the definition of an ED frequent user has differed overtime, although most literature agrees that a frequent user is a person who makes four or more emergency department visits in a 12-month period (Byrne et al., 2003; Grover & Close, 2009; Hunt, Weber, Showstack, Colby, & Callaham, 2006; Ledoux & Minner, 2006; Locker, Baston, Mason, & Nicholl, 2007). Some have used different thresholds to define ED frequent users. Blank et al. (2005) and Chan and
Ovens (2002) used a standard of 12 or more ED visits in a 12-month period, whereas others have used lower thresholds, such as Zuckerman and Shen (2004) who 3 or more ED visits in a 12-month period to define frequent users. Changing the inclusion criteria for who is an ED frequent user obviously changes the volume of people included in the population, but also changes the demographics and characteristics of the population, as evidenced by a simple comparison of the data presented in Tables 2 and 3. Therefore, the decision of which threshold to use as the definition of an ED frequent user has a bearing on what inferences researchers will make about the characteristics and demographics associated with ED frequent users.

Assuming a definition of four or more ED visits in a year as constituting an ED frequent user, it has been estimated that 4.5-8% of ED-using population are ED frequent users, and that they make 21-28% of all ED visits per year (LaCalle & Rabin, 2010). To put this in perspective, in 2013 there were 130.4 million ED visits (Centers for Disease Control and Prevention, 2017a). This means that approximately 27.4-36.5 million ED visits were made by ED frequent users in 2013. Moreover, using the same definition, there is some evidence that indicates that the number of ED frequent users has been growing overtime—with a study conducted at a single site finding a 66% increase in ED frequent users over a 10-year period (Martin, Stokes-Buzzelli, Peltzer-Jones, & Schultz, 2013).

**Characteristics of ED Frequent Users**

Understanding the composition of this group is a necessary starting point for the development of a typology of ED frequent users. Much work has been done to characterize ED frequent users over time, with an emphasis on single-site studies. Therefore, a comprehensive review of the descriptive literature on ED frequent users is necessary to get the full picture of ED frequent users in the United States.

Contrary to many expectations, general characteristics of ED frequent users include the tendency to be insured (Blank et al., 2005; Hunt et al., 2006; LaCalle & Rabin, 2010; Peppe, Mays, Chang,
Becker, & DiJulio, 2007; Rabin, 2011) but disproportionately insured by the public insurers Medicaid and Medicare (LaCalle & Rabin, 2010; Lucas & Sanford, 1998; Mandelberg, Kuhn, & Kohn, 2000; Peppe et al., 2007; Richardson & Hwang, 2001; Vinton, Capp, Rooks, Abbott, & Ginde, 2014; Zuckerman & Shen, 2004). One reason for this, at least in more recent times, may be because hospital-based emergency rooms are commonly staffing people to enroll uninsured patients in Medicaid as a result of the Patient Protection and Affordable Care Act (ACA) (Varney, 2014). The high prevalence of Medicaid ED frequent users is further consistent with the finding that many ED frequent users also frequently come from low-income households (Hunt et al., 2006; Peppe et al., 2007). Specifically, policies that expand Medicaid access are commonly associated with short-term increases in emergency department utilization (Lo et al., 2014), which is believed to decrease over time as new health care users learn to navigate the health care system; increasingly utilizing primary care resources over emergency department resources as this familiarity increases (Taubman et al., 2014). Other reasons why Medicaid beneficiaries have a high prevalence of ED frequent users may be because primary care physicians are less available during off-hours when workers without flexible work schedules or paid time off benefits are available (LaCalle & Rabin, 2010). Additionally, as Bodenheimer (2013) explains, Medicaid beneficiaries are more likely to suffer from social problems like housing insecurity or poor food access which can complicate health problems, leading to more acute need for emergency care (Billings & Raven, 2013). Research has demonstrated those who have housing instabilities or food insecurity are more likely to postpone needed medical care and medications, and have increased utilization of ED and inpatient hospital resources (Kushel, Gupta, Gee, & Haas, 2006). Furthermore, the stress associated with housing instability has been shown to be associated with incident hypertension in some populations (Vijayaraghavan et al., 2013).

The disproportionate share of ED frequent users with Medicare insurance is generally believed to be due to the fact that Medicare individuals have higher health care needs—given their advanced
age, and the availability of medical technology available to extend life (Goldman & Gaudette, 2015). Additionally, given the aging baby boomer population, there are simply just a larger number of people moving into the Medicare population, which may also explain why there are a large number of Medicare-covered ED frequent users. While it would seem prudent for Medicare beneficiaries to utilize a primary care physician instead of the ED, primary care physicians are not available at all times, and acute conditions (or acute symptoms) sometimes truly warrant the use of the ED. Additionally, some people, especially low-income individuals and certain racial minorities, prefer the ED over private primary care physicians because they believe they receive higher quality care in the ED (Kangovi et al., 2013). It may be the case that some Medicare beneficiaries share this belief, thus increasing their reliance on the ED over the primary care office.

In terms of health status, high frequency users tend to have both poor mental (Billings & Raven, 2013; Byrne et al., 2003; Hunt et al., 2006; Peppe et al., 2007) and physical health (Hunt et al., 2006; Peppe et al., 2007; Vinton et al., 2014; Zuckerman & Shen, 2004). This results in emergency department frequent users having a substantially higher overall illness burden, with a larger presence of chronic disease compared to non-frequent users (Billings & Raven, 2013; Mandelberg et al., 2000; Peppe et al., 2007; Vinton et al., 2014). Chronic conditions like diabetes and asthma can result in more ED visits to treat crises, especially if the disease is not well-managed. The ED visit itself, of course, triggers the ordering of numerous tests to rule out more acute health problems, increasing health care costs, as previously discussed. Additional conditions that have been found to be more common among ED frequent users compared to non-ED frequent users include: migraine headaches, sickle cell anemia, alcohol withdrawal, renal failure, alcohol dependence, COPD, seizure, asthma, and alcohol intoxication (Chan & Ovens, 2004; Mandelberg et al., 2000). Many of these conditions are notoriously difficult to manage or “cure”, requiring substantial effort and, in some cases, financial resources, on the part of the
patient (for example, addiction and renal failure both require a strong commitment to treatment goals and processes to successfully manage the underlying condition).

Most evidence supports that ED frequent users make more ED visits for mental/behavioral health issues, or substance abuse problems than non-frequent users (Fuda & Immekus, 2006; Liu et al., 2012; Mandelberg et al., 2000). However, this characteristic may not be true of all ED frequent users. Billings and Raven (2013) suggest that higher rates of substance abuse and mental health problems are more common in the very-high ED utilizing population (those who make 10 or more ED visits per year), and not as prevalent among those who make less than 10 ED visits per year. Additionally, Vinton et al. (2014) found that in a national dataset on emergency room visits, frequent ED users did not present to the ED more often than non-ED users for alcohol or tobacco abuse, suggesting, perhaps that there is only a subpopulation of ED frequent users for whom substance abuse and/or mental health concerns are truly problematic. However, Brennan, Chan, Hsia, Wilson, and Castillo (2014) found that people who made primary psychiatric visits were 4.6 times more likely to become an ED frequent user than those who made no primary psychiatric visits during the same one year period—suggesting psychiatric illness may be a risk factor for ED frequent use. Taken together, existing evidence suggests some degree of heterogeneity within the ED frequent user population with respect to mental health and substance abuse disorders, although the degree of disparateness is still not fully understood or agreed upon.

Drug-seeking specifically is also a common topic with respect to ED frequent users. The popular press has often characterized ED frequent users as people who come to the ED looking for pain medication. An analysis of injection drug users by Kerr et al. (2005) showed that injection drug users frequent both the ED and primary care physicians with high-regularity. Most ED visits for this population were for abscesses, cellulitis, and related skin infections that can occur as a result of injection drug use (Kerr et al., 2005). While ED frequent users may be commonly stereotyped as drug-seekers; this is not a commonality among the entire population of ED frequent users (LaCalle & Rabin, 2010). However,
despite a lack of evidence suggesting that most ED frequent users are drug-seekers, a survey of ED staff members showed that many staff commonly believe ED frequent users are there seeking pain medication, demonstrating the persistent view of these patients as drug-seekers (Hsieha et al., 2013). Negative provider attitudes towards ED frequent users can impact the quality of care delivered, as well as the degree to which the patient is satisfied with the visit. It is easy to see how it would be frustrating for an ED frequent user with poorly controlled sickle cell anemia would be frustrated by being viewed as presenting to the ED “just to get pain medicine”, rather than for his or her legitimate and acute health concern. At the same time, pain is a frustrating metric for health care providers, since there is no objective way to measure a patient’s pain, thus, pain must be measured by patient’s personal subjective assessment of pain levels. This lack of being able to truly assess pain like other vital signs can take a toll on health care providers and many describe feelings of frustration, guilt, and a lack of gratification (Matthias et al., 2010).

Customer service concerns are not uncommon in the ED frequent user population. Studies show that ED frequent users are typically dissatisfied with the medical care they receive (Hunt et al., 2006; Peppe et al., 2007). This is in contrast to work by Kangovi et al. (2013) that found that low-income populations of ED users (albeit any level of ED use) prefer to receive care in the ED because they believe EDs deliver higher quality care. The distinction here is that the work by Kangovi et al focuses on low-income ED users, rather than frequent ED users. Data has demonstrated that many ED frequent users are low-income, thus there is some crossover between the two groups (low-income ED users and frequent ED users) which is likely causing heterogeneity with respect to ED care satisfaction in the ED frequent user population. Other service delivery issues have been found to be unacceptable to uninsured patients who are frequently low-income. In one study, uninsured patients who opted to use an emergency department that would bill for services rather than a local free public hospital were surveyed (Weiner, Vangeest, Abrams, Moswin, & Warnecke, 2006). The results of the survey showed
that excessive wait times were a primary reason for not returning to the free hospital, indicating that free care is not worth the cost of spending hours in an emergency department waiting room for all uninsured people (Weiner et al., 2006). Taken together, it should be recognized that there is likely a subgroup of ED frequent users, not the entire population, that are unsatisfied with the care they receive; and that at least some of them are willing to go to extreme lengths (even attending a hospital they cannot afford) to receive treatment.

Ruger et al. (2004) demonstrated high rates of elopement and patients signing out AMA which further suggests that some ED frequent users are dissatisfied with the care they receive, specifically those who made 20 or more ED visits per year, further demonstrating heterogeneity with respect to this aspect of ED frequent use. Typically if a patient is leaving against medical advice, there is some level of dissatisfaction. Furthermore, physicians are often concerned about the impact ED frequent users have on patient satisfaction surveys, due to their frequent use and their general dissatisfaction with health care services. However, evidence suggests that ED frequent users may be under-sampled because many ED surveys are not re-sent to patients who have been seen in the ED in the past 90 days (American College of Emergency Physicians, 2011).

Despite an individual’s attitudes towards the emergency department, when serious symptoms strike, there are very limited options for where medical treatment can be obtained, and it is very likely the ED will be the only place someone can turn to on short-notice, or when they experience serious or seemingly life-threatening symptoms. The reasons why ED frequent users present to the emergency department are generally due to the perception of their health problem as emergent, and in need of immediate attention (Birmingham et al., 2017; Olsson & Hansagi, 2001). While this evidence suggests that ED frequent users believe they are sick when they come to the ED, other evidence has shown that ED frequent users present to the ED with higher acuity and severity scores than non-frequent ED users—indicating that ED frequent users are truly sick when they present to the ED. ED frequent users are more
likely than non-frequent users to die at an ED visit or subsequent inpatient admission—also an indication of serious health problems (Fuda & Immekus, 2006; Hansagi, Olsson, Sjoberg, Tomson, & Goransson, 2001). Additionally, ED frequent users are more likely than non-frequent users to be admitted to an inpatient unit following an emergency visit (Byrne et al., 2003; Fuda & Immekus, 2006; Hansagi et al., 2001; LaCalle & Rabin, 2010).

Overall, many Americans receive care for non-emergent conditions in the emergency room (Weinick et al., 2010). Frequent ED users are often thought of as people who frequently use the emergency department for primary care, although there is a lack of evidence to support this claim, and little agreement on which conditions constitute being labeled primary care sensitive conditions. Literature suggests that frequent ED users are not more likely than non-frequent ED users to use the ED for primary care sensitive conditions (Doran et al., 2014; Liu et al., 2012). One caveat to this point is that users with 20 or more ED visits in a year have been found to present to the ED for lower severity health problems (Ruger et al., 2004), further indicating the heterogeneity of this population.

It has been well-established in the literature that frequent ED users are indeed primary care users (Billings & Raven, 2013; Byrne et al., 2003; Hunt et al., 2006; LaCalle & Rabin, 2010; Lucas & Sanford, 1998; Vinton et al., 2014). In fact, ED frequent users are high-utilizers of other medical services outside the emergency room including outpatient or specialist care (Billings & Raven, 2013; Byrne et al., 2003; Hunt et al., 2006; LaCalle & Rabin, 2010; Peppe et al., 2007; Vinton et al., 2014; Zuckerman & Shen, 2004). This indicates that ED frequent users may also be accruing large health care expenditures outside of the emergency department, just like they are within the emergency department. This means that any intervention focused on ED frequent users needs to also take into account that these individuals also use other areas of the health care system with high frequency, and that only reducing ED visits may only make minor reductions in their total health care cost footprint.
Lastly, some studies suggest that a number of frequent ED users may suffer from severe deprivation. For example, some have found high rates of homelessness among their hospital-specific ED user populations (Kushel, Perry, Bangsberg, Clark, & Moss, 2002; Lin, Bharel, Zhang, O'Connell, & Clark, 2015; Thakarar, Morgan, Gaeta, Hohl, & Drainoni, 2015). Publications of ED frequent users coming from San Francisco and Boston have largely come to this conclusion, although not all studies characterizing ED frequent users have found universally high proportions of homelessness (LaCalle & Rabin, 2010; Mandelberg et al., 2000; Okin et al., 2000). A study examining emergency department utilization among a homeless population found that approximately 40% of homeless individuals had used the ED in the previous year, and 8% of homeless people had visited the ED 3 or more times in the previous year (Kushel et al., 2002). Those high-use individuals accounted for over half of the ED visits made by the entire population of homeless individuals surveyed (Kushel et al., 2002). An examination of this subgroup showed that several factors were associated with using the ED at higher rates, among homeless people, including: criminal arrests, less stable housing, physical and mental illness, substance abuse, and victimization (Kushel et al., 2002). This highlights how social problems may be a factor contributing to high utilization of the emergency department among frequent ED users (Bodenmann et al., 2014).

Violence is another social problem that appears to have some association with ED frequent use. One study examining the effect of an intervention for ED frequent users used personal history of violence and/or abusive behaviors as inclusion criteria for the intervention—suggesting that this is at least a subgroup among ED frequent users (Pope, Fernandes, et al., 2000). Evidence has shown that ED frequent users are more likely to be unemployed than non-frequent users, and less likely to have a college degree—but more likely to have some college (Doran et al., 2014).

While frequent ED users use a substantial amount of health care resources, this population usually exhibits such utilization for limited periods of time (Billings & Raven, 2013; Fuda & Immekus,
2006; Johnson et al., 2015; LaCalle & Rabin, 2010; Mandelberg et al., 2000). The most recent analysis examining this issue found that 28% of identified frequent ED users remained frequent ED users for an additional year, and 14% at the end of the second year (Johnson et al., 2015). Another analysis that examined characteristics of ED frequent users by the number of ED visits made in a year found that those who made larger number of visits in the index year tended to sustain their high utilization for years (Billings & Raven, 2013). This suggests heterogeneity with respect chronic frequent ED use by demonstrating that those who use the ED with extreme frequency have a greater tendency to sustain high ED utilization over multiple years.

Overall, due to the heterogeneity of ED frequent users, they are an often misunderstood population with respect to the popular press, and in many cases, peer-reviewed literature. One study conducted an analysis of unsubstantiated assumptions stated in scholarly literature about ED frequent users and found that nearly half of the published literature reviewed on ED frequent users contained at least one incorrect assumption (Newton, Keirns, Cunningham, Hayward, & Stanley, 2008). Common incorrect assumptions about ED frequent users include: (1) a prevalence of non-insurance within the ED frequent user population, (2) deficiencies in primary care physician access and utilization, (3) ED frequent users as a primary source of ED overcrowding, and (4) primarily lower acuity use of the ED than the total ED-using population (Newton et al., 2008). If interventions are being developed based on the popular press and the literature, it may be the case that current interventions are not addressing the real needs of ED frequent users because there are systematically incorrect assumptions in the published literature.

In short, ED frequent users are generally insured (disproportionately by public payers), present to the ED with acute health issues, suffer from chronic illness, are connected to primary care and other medical specialties, and believe their reasons for presenting to the ED are emergent. Most ED frequent users do not remain in a high-utilizing status for extended periods of time—rather, the frequent use
occurs for a finite period of time, generally less than one year, although there is a subset of ED frequent users, typically those with very high ED utilization, who chronically use the ED for an extended period of time. There is not well-established homogeneity with respect to age, race/ethnicity, or gender within the ED frequent user population.

**Factors Impacting ED Utilization**

While individual characteristics may shape to a certain degree the type of services utilized by ED frequent users, there are a number of overarching factors, including policy, that actually drive the observed increases in ED utilization.

**Policies Impacting Emergency Department Care and Utilization**

**Hill-Burton Act of 1946**

Frequent ED users are a modern phenomenon, primarily because hospitals, as we know them today, are also a modern phenomenon. Prior to the World War II era, hospitals were used primarily to treat the poor, and much health care was performed in the home. It was not until the Hospital Survey and Construction Act (also called Hill-Burton Act) of 1946 that hospital buildings proliferated in the United States. This legislation provided funds for building community hospitals. In the period from 1946 to 1965, the number of hospitals grew from 4,523 to 5,736, representing a 21% increase (Zink, 2005). As demographic patterns shifted during the baby boom, more hospitals continued to be built to anticipate the needs of a growing population (Zink, 2005). This increase in hospitals was accompanied by a commensurate increase in hospital-based emergency departments.

The number of hospitals, however, began to slightly decline in the 1980s, and even more so through the 1990s and 2000s, as hospital consolidation became more aggressive (Centers for Disease Control and Prevention (CDC), 2011). This has consequently resulted in hospital-based emergency department closures (Hsia et al., 2011). However, since emergency departments became important
portals into inpatient admissions, the primary revenue generator for hospitals, hospitals established freestanding emergency departments (not physically connected to the hospital, rather, located in convenient community locations). While some states have different regulations for freestanding EDs than for hospital-based EDs, the vast majority of freestanding EDs are capable of treating emergent cases in the same way hospital-based EDs do. Granted, the most emergent cases (traumas, heart attacks, strokes) are typically not be transported by emergency medical transportation to a freestanding ED. In the event that a case that requires greater resources than are available in a freestanding ED is brought to a freestanding ED, transfer to a hospital-based ED is typically required. Given that the these types of health problems are relatively rare with respect to the types of conditions an ED treats on a daily basis, a freestanding ED is well-positioned to provide care for the majority of cases that come through the door. As a result of their popularity with both patients and hospitals, the number of freestanding EDs in operation grew 76% from 2008 to 2015 (Harish et al., 2016). Patients tend to prefer the convenient community locations of freestanding EDs and the normally shorter wait-times (compared to busy hospital-based EDs) (Bucciarelli, Payton, Weeks, & Falgiani, 2015). Freestanding EDs represent another strategy that health systems can use to capture market share. Given the increasing role of the ED as the gatekeeper to inpatient admissions (still a primary revenue source for hospitals), locating EDs in community settings helps funnel inpatient business to hospitals that transfer acute patients from freestanding EDs to tertiary care hospitals. Furthermore, the health system is able to influence the payer mix by locating freestanding EDs more frequently in wealthier communities, as has been consistently observed across the United States (Schuur et al., 2016). Thus, while the environment in which emergency care is delivered is changing (the hospital vs. the freestanding ED), EDs maintain a strong presence in most American communities.

Even as far back as 1946 Congress specifically wrote that in order to receive money under Hill-Burton, hospitals were mandated to provide emergency medical services to any person living in its
service area who could not afford emergency treatment, and needed to admit people despite race, color, national origin, or creed (Department of Health and Human Services, nd). This formally established the emergency department as part of the public health safety net, by specifically saying it must treat all people, despite ability to pay. However despite good intentions from Congress, some portions of the law were not strongly enforced, leading to discrimination against low-income and minority patients (Balter, 1985) and a general failure to protect low-income and uninsured patients from. A 1982 Government Accountability Office (GAO) investigation uncovered hundreds of unresolved complaints against hospitals violating Hill-Burton for various reasons including discrimination based on race, refusal to admit critically ill patients to the emergency room because they did not have a private physician or were insured by Medicaid (Balter, 1985). To make matters more complicated, several court cases had established that most hospitals had “no duty” to provide emergency care for patients—especially privately owned hospitals (U.S. Commission on Civil Rights, 2014), thus undermining much of the power of Hill-Burton. As a result, hospitals continued to dump uninsured and low-income patients on county-owned hospitals. One study examined the transfers to a public hospital in Chicago and found that only 6% of transferred patients had given consent to be transferred, and 87% lacked medical insurance (Schiff et al., 1986). The “no duty” role comes from the common law that did not require physicians or hospitals to provide life-sustaining treatment or any medical treatment to those in need of emergency care. A physician would only have a duty to treat, according to tort theory, if there was “an actual or consensual agreement creating a physician/patient relationship” (Conrad, 1992). The issue of refusing care to patients came to a head in 1986 when the Emergency Medical Treatment and Active Labor Act (EMTALA) law was passed.

**Emergency Medical Treatment and Active Labor Act (EMTALA)**

In the face of ongoing tensions regarding requirements to provide care for indigent patients, Congress passed the Emergency Medical Treatment and Active Labor Act (EMTALA). EMTALA was part of
the Consolidated Omnibus Budget Reconciliation Act (COBRA) passed in 1986. COBRA was a larger piece of legislation that affected health insurance provisions for individuals and employers, popularly known for its insurance continuance provision that gives employees that option to extend health insurance coverage after parting from employment. EMTALA requires hospital-based emergency departments to provide a medical screening exam and appropriately stabilize patients and transfer them to an appropriate resource if necessary—all regardless of ability to pay. If hospitals are found to violate this, they are fined. A single negligent violation of EMTALA can result in a fine of up to $50,000 (Fosmire, 2009). Additionally, if EMTALA violations are not corrected, hospital participation in Medicare and Medicaid can be terminated, which would effectively but a hospital out of business (U.S. Commission on Civil Rights, 2014).

EMTALA was developed primarily to address unfair access to emergency services for low-income and uninsured groups, but subsequently helped to level the playing field for the hospitals who had disproportionately been footing the bill for uncompensated ED care through what became known as “patient dumping”. Long before the development of EMTALA and the modern diagnosis-related group payment (DRG) system, hospitals were able to select how much they would charge patients. This resulted in a practice called cost-shifting (Monico, 2010) where hospitals charged patients with more generous insurance a higher price than the price charged to those with less generous (or no) insurance. This was often employed to help offset the cost of providing charity care (also known as uncompensated care). This practice was no longer possible with the implementation of the DRG system in 1983 which standardized the amount of money that would be reimbursed for inpatient healthcare services. Since hospitals were no longer able to cost-shift, providing care for low-income patients became financially more difficult. Hospitals started being more selective about the patients they served, favoring those with more generous insurance or ability to pay (Schiff et al., 1986). Evidence surfaced that showed that those who were unable to afford emergency care were more frequently transferred to public EDs or
were refused care (Schiff et al., 1986). Prior to EMTALA, it was estimated that hospitals refused to serve 250,000 patients each year on the basis of income or non-insurance (U.S. Commission on Civil Rights, 2014). While EMTALA is believed to have reduced the incidence of patient dumping, the practice still occurs, and in more recent times increasingly with psychiatric patients (U.S. Commission on Civil Rights, 2014). A report on patient dumping was published by the United States Commission on Civil Rights in 2014. This report detailed instances of patient dumping still occurring—profiling one particular organization, Rawson-Neal, a psychiatric hospital in Nevada, that would regularly discharge patients to bus stations with one-way tickets to other states, and instructions to call 911 upon arrival, with limited supplies of food, water, and medications. Evidence shows that approximately 1,500 patients were bused from the Las Vegas psychiatric hospital under these conditions (Hubert & Reese, 2013). Stories like this, and others, suggest that patient dumping is still a problem that persists in our health care system.

As a result, EMTALA has led to emergency departments being considered a “safety net” provider (Institute of Medicine, 2000). The Institute of Medicine defines a safety net provider as a health care provider who takes care of vulnerable populations—specifically the uninsured, Medicaid, or other populations unable to afford healthcare (Institute of Medicine, 2000). Some take this further, and consider EDs to be the “safety net of the safety net”, or the “provider of last resort” (Institute of Medicine, 2007), indicating that people can use the emergency department, even if all other options have been exhausted. While this is an important mission of some non-profit hospitals, being a safety net provider comes with financial challenges. EMTALA has led to the emergency department being a primary source of care for uninsured and underinsured populations, or those who cannot receive any level of care from other provider (Richardson & Hwang, 2001). Underinsured patients cannot be overlooked in this context, as there are circumstances where very high deductibles or limitations in coverage leave patients effectively uninsured because of gaps in coverage, or an inability to pay high deductibles. While this may be appropriate to provide this type of care for a population that has no
alternative, it does mean that the ED gets used for non-emergent health concerns. The American College of Physicians (ACEP) explicitly states that they believe access to emergency medical is a fundamental right of individuals, and that patient welfare is a primary professional responsibility (American College of Emergency Physicians, 2016). Furthermore, ACEP specifically states that emergency physicians must advocate for public health, which includes the provision of basic care for uninsured patients, providing further support for the role of the ED in the public health safety net (American College of Emergency Physicians, 2016).

It should be noted that EMTALA does not require emergency departments to provide healthcare for all who seek it. It only requires the medical screening exam, stabilization, and if necessary, transportation to an appropriate facility. After the enactment of EMTALA in 1986, in the 1990s, some emergency departments implemented policies where patients with complaints deemed non-emergent would be refused ED care (Richardson & Hwang, 2001). This policy was not a commonplace practice at all institutions, and has largely fallen out of practice after numerous data-driven reports demonstrated problems with these practices and editorials questioned the ethics of ED-refusal policies (Richardson & Hwang, 2001). Furthermore, the marginal cost of seeing a low acuity patient has been found to be relatively low, thus expending effort to sort patients into high and low acuity cases may be more costly than it is worth, especially when the downside risk is also costly (Bamezai et al., 2005; Williams, 1996). The increasingly strict enforcement of EMTALA by the Health Care Financing Administration (HCFA) and subsequently Centers for Medicare and Medicaid Services (CMS) has had a chilling effect on patient refusals, given the threat of fines or lose of non-profit status (Richardson & Hwang, 2001). While EMTALA violations are rare—only 1.7 citations per million ED visits (Terp et al., 2016)—given the large volume of ED visits in the country, approximately half of all hospitals had an EMTALA investigation and 27% were cited during a 10-year study period (Rhodes & Smith, 2016). Thus, while the probability of any one ED visit resulting in a fine is small, the long-term risk of exposure to EMTALA violations is very real,
especially for large volume EDs. Furthermore, physicians can be held individually liable if an EMTALA violation is found, and these fines are not traditionally covered by malpractice insurance (Terp et al., 2016) thus further increasing the chilling effect on patient refusals.

While EMTALA helped in reducing patient dumping, negative unintended consequences of EMTALA have been suggested in the scholarly literature. EMTALA has been blamed for many things including ED overcrowding, reduced quality of care, increased ED wait times, increased (non-reimbused) costs of care and increased numbers of patients who leave without being seen (Rhodes & Smith, 2016). Work by Weiner et al. (2006) demonstrates that the promise of free emergency department care cannot overcome the costs of excessive wait times. In a study of uninsured patients who opted to use an emergency department that required payment over a free county-owned emergency department, excessive wait times were often cited as a reason for choosing not to use the no-cost ED option (Weiner et al., 2006). This illustrates that EMTALA imposes a burden of uncompensated care on EDs, even when low-cost or no-cost alternatives exist for patients. Others have suggested that EMTALA has made it more difficult for hospitals to find specialists willing to be on-call, given the probability of the specialist physician needing to take call for uninsured patients for whom they will not be reimbursed (McConnell, Newgard, & Lee, 2008). Lastly, EMTALA has had a negative impact on hospital finances for hospitals that see a larger share of uncompensated patient visits (also known as bad debt) (Department of Health and Human Services, 2001; Fields, 2000; Fields et al., 2001).

EMTALA itself has been criticized for not being an effective piece of health policy legislation. Rhodes and Smith (2016) state “...there is no evidence that EMTALA has improved meaningful access to care or reduced disparities in outcomes for vulnerable populations”. A similar sentiment was shared in Terp et al. (2016). Rhodes and Smith (2016) also point out that EMTALA only protects patients that are having medical emergencies. Once the medical emergency ceases to exist, the patient can be discharged, even if they are still not well. EMTALA is also a difficult piece of legislation for hospitals,
since they are mandated to provide care, but no additional funding was allocated with EMTALA to cover the costs of such care, further shrinking hospital margins.

The Balanced Budget Act

As concerns for growing health expenditures grew through the 1990s, a second policy that impacted ED utilization was passed—the Balanced Budget Act of 1997. This legislation was predicted to reduce Medicare payments by approximately $116 billion from 1998-2002—primarily through reduced payments to hospitals, but also increased beneficiary contributions to Part B premiums (Commonwealth Fund, 1997). Prior to this legislation, some insurers had denied payment to EDs for providing non-emergent care to beneficiaries—passing the cost onto the beneficiary. The threat of ED care denial by insurers was believed to reduce the use of the ED for non-emergent conditions, in an effort to control costs. This law requires Medicare and Medicaid managed care plans to pay for ED visits that a “prudent layperson” would believe to require immediate medical attention. This law protects patients from bearing the full cost of an emergency department visit for a health problem that turns out to be non-emergent when the initial symptoms were seemingly emergent. Research has shown that many of the health problems that had been denied coverage for being non-emergent prior to the Balanced Budget Act of 1997, would be covered under the legislation’s “prudent layperson” standard (Tintinalli, 2000). Studies demonstrated that 10-40% of nonurgent ED claims that would have met the “prudent layperson” criteria were denied by insurance companies prior to the passage of Balanced Budget Act of 1997 (Centers for Disease Control and Prevention, 2001). According to the CDC, after the passage of the legislation, “hospitals received more reimbursement for emergency care provided to insured patients, and there was a commensurate rise in the use of both urgent and non-urgent services” (Centers for Disease Control and Prevention, 2001).

Additionally, the Children's Health Insurance Program (CHIP) was created by the 1997 Balanced Budget Act. This legislation provided health insurance coverage to low-income children and, if states opt
to participate, additionally for pregnant women, through a federal-state partnership. CHIP provides
coverage to pregnant women and children who are not low-income enough to receive Medicaid, but are
still low-income (Paradise, 2014). This coverage was reauthorized in 2009 under President Barack
Obama under the Children Health Insurance Program Reauthorization Act (CHIPRA)—extending CHIP
through 2013. Another important piece of health policy legislation, the Patient Protection and
Affordable Care Act, extended CHIP coverage through 2015. Evidence shows that CHIP has been
successful in helping children gain insurance coverage and access to healthcare providers—even
children in the more vulnerable categories including the long-term uninsured, disabled, and minority
children (Dick et al., 2004). Additionally, children covered by CHIP are more likely to have a primary care
physician, dentist, and better continuity of care than low-income children not on CHIP (Eisert & Gabow,
2002; Holl et al., 2000; Lave et al., 1998). Evidence also shows that children covered by CHIP are less
likely to use the emergency department than uninsured children (Eisert & Gabow, 2002). Data from the
Kaiser Family Foundation estimates that approximately 8.4 million children were covered by CHIP in
2015 (Kaiser Family Foundation, 2017). In short, it is believed that CHIP has successfully helped to
improve the health and well-being of children and their families (Lave et al., 1998).

**Patient Protection and Affordable Care Act (ACA)**

The Patient Protection and Affordable Care Act was a milestone in health care policy. Passed in
2010, the ACA had several major components, but included three items critical to ED utilization: (1) an
insurance mandate—mandating all citizens maintain health insurance- in addition to the creation of
“insurance exchanges” or marketplaces where people could buy health insurance, and (2) Medicaid
expansion—where Medicaid would be expanded to additional low-income individuals (after a Supreme
Court consideration- this became optional for states to participate); and (3) inclusion of emergency care
in the 10 essential benefits that health plans must offer. These provisions of the ACA are believed to
have impacted emergency department utilization.
First, historic expansions of Medicaid have been associated with an increase in emergency department utilization. Given that the ED is used disproportionately by Medicaid beneficiaries (Richardson & Hwang, 2001), when additional people are added to Medicaid, emergency utilization tends to increase (Chen, Scheffler, & Chandra, 2011; Taubman et al., 2014). Some research indicates that these increase in utilization are not sustained over the long-term as beneficiaries find alternatives to the ED (Lo et al., 2014). As newly insured Medicaid beneficiaries learn how to use their new insurance and new access to healthcare providers, they substitute away from the ED. One study found that in Illinois, where Medicaid was expanded, an increase in ED visits that did not result in hospitalization occurred within Medicaid beneficiaries after the ACA implementation (Dresden et al., 2017). This does not mean these visits were unnecessary, but rather, means the visits occurred for health problems that did not require hospitalization. In fact, a further analysis showed that there was no subsequent increase in ED visits for ambulatory care sensitive conditions after Medicaid expansion in the state of Illinois (Sharma, Dresden, Powell, Kang, & Feinglass, 2016).

Additionally, the insurance mandate that requires all people to have insurance may have increased ED utilization as well, but not at the level observed by Medicaid beneficiaries (Ginde, Lowe, & Wiler, 2012). There is heterogeneity in the population who increased their ED utilization. While some data suggests that those who gained insurance under the ACA started using the ED with greater frequency, other data suggests that some populations actually decreased their ED utilization after the implementation of the ACA—namely young adults (Hernandez-Boussard, Burns, Wang, Baker, & Goldstein, 2014) likely as a result of the successful gains in coverage and access for this population (Sommers, Buchmueller, Decker, Carey, & Kronick, 2013). The Ginde et al. (2012) analysis strikes the most probable balance—indicating the those who had new insurance coverage were most likely to the use the ED (especially those on Medicaid)—while those with continuous insurance coverage were no more likely to use the ED before or after the ACA.
Another element of the ACA that potentially increases ED utilization is the inclusion of emergency care in the 10 essential benefits. This policy requires insurance plans to cover emergency department care with no dollar limit as part of any plan. Generally increased insurance coverage is believed to increase consumption (Newhouse, 1993), so this policy may also impact ED utilization for all payers—including private payers. The seminal RAND health insurance experiment showed that when insurance coverage is more generous, and people are shielded from the true costs of their consumption, they tend to consume more health care services (Newhouse, 1993). Research on changes in ED utilization as a result of the ACA continues to be performed. Dresden et al. (2017) found that privately insured ED visitors visited the ED with higher frequency after implantation of Medicaid Expansion (which was also around the same time as the implementation of the ten essential benefits requirement). However, the increase in privately insured ED visitors was much smaller than Medicaid-insured visitors—an increase in 1.3 ED visits per 1000 population vs. 10.2 ED visits per 1000 population (Dresden et al., 2017). This does, however, suggest that including emergency care in the 10 essential benefits may have had a positive effect on ED visit growth.

Other smaller elements of the ACA are expected to have downward pressure on ED utilization—including patient-centered medical homes (PCMHs), accountable care organizations (ACOs), and bundled-payment contracts (McClelland et al., 2014). Patient-centered medical homes aim to provide better coordinated care and more timely access to providers during times when patients are truly sick. Some evidence has shown that PCMHs have been able to reduce ED utilization (Gonzalez Morganti et al., 2013). Similarly, ACOs, which are supposed to offer high levels of coordinated care, are believed to reduce ED utilization in the same manner as PCMHs, although there are stronger financial incentives for ACOs. Data on ED utilization changes as a result of ACO implementation has yet to be published, although some reports speculate that ACOs will try to decrease ED utilization (American College of Emergency Physicians, 2012). Bundled-payment contracts are similar to older capitation models where a
set amount is reimbursed for a particular service, thus unexpected ED visits would only erode provider profits. This practice is believed to incentivize providers to provide higher quality care—subsequently keeping patients out of the emergency department. To date, data has not shown changes in ED utilization as a result of bundled payment contracts (Sharp, Song, Safran, Chernew, & Mark Fendrick, 2013).

As a result of the ACA, some have argued that the emergency department will take a greater role in managing population health. Given the frequent touches the ED makes with patients, especially frequent ED users, the ED will be critical to the care coordination process. The trend towards using observation units as an alternative to admission or typical ED care will also become something ED physicians grow into as a result of ACA—since many observation units are housed in emergency departments, and sometimes controlled by ED administration (Venkatesh et al., 2011). Furthermore, given the frequent touches the ED makes with frequent users, some EDs have begun to engage in intervening with these populations—either through intensive care management or other means—to reduce their ED reliance (Kumar & Klein, 2013; Soril et al., 2015). However, no randomized controlled trial to date has shown a statistically significant decrease in hospital or ED costs as a result of such an intervention (Soril et al., 2015).

In summary, the ACA has had a mixed effect on the emergency department—much of what has yet to be fully realized. With potential ACA-related policy changes in the future given interest in a repeal and replacement of the ACA via the American Health Care Act (AHCA), the effect of all unique aspects of the ACA on emergency department utilization could become difficult to parse out as time goes on. It has been shown that ED utilization has increased, at least for newly insured individuals—especially those on Medicaid—but given previous Medicaid expansion experiments—this utilization is expected to decrease as people learn how to use their newfound insurance. The population health innovations—PCMHs, ACOs, and bundled payment—may still need time to take effect before their impact on ED utilization is
truly understand. Bundled payment programs are still in their infancy, with very little evidence on their
effectiveness or ability to generate cost-savings (Bertko & Effros, 2010), and ACOs, of which there were
only 838 in 1Q2016 covered 28.3 million lives out of a population of over 300 million (Muhlstein &
McClellan, 2016).

Organizational Processes Impacting Utilization

The effects of policy are often compounded by organizational processes that develop as a result
of policy. These organizational processes subsequently impact ED frequent users. In a prospective
analysis by Hudon, Sanche, and Haggerty (2016), it was determined that lower perceived organizational
access, coordination problems with health care appointments, and a lack of annual check-ups were
associated with becoming an ED frequent user.

Outside of the hospital, the availability of primary care providers and the characteristics of their
practices are believed to impact ED utilization. McCusker et al. (2009) established that primary care
practices that did not conform to best practices for primary care were more likely to have repeat ED
visitors when compared to practices that conformed to known best practices. It is known that patients
of primary care physicians (PCPs) who have more night or weekend hours typically have lower ED
utilization than patients of PCPs who have less off-hours availability (Lowe et al., 2005). When a
physician’s time is divided among many patients or competing duties, ED utilization rates increase.
Having a larger patient panel, or high patient-to-physician ratio, is also associated with higher ED
utilization (Lowe et al., 2005). Additionally, when PCPs do inpatient rounding they tend to have high ED
utilization among their patients (Haggerty, Roberge, Pineault, Larouche, & Touati, 2007; Lowe et al.,
2005). In a similar vein, patients who perceive easy and timely access to their PCP is associated with
reduced ED utilization (Haggerty et al., 2007). In short, primary care physicians who do not have as many
demands on their time (or are perceived to be less busy by patients) are associated with reduced ED
utilization.
Interestingly, ED usage has also been found to be higher among patients from practices with nurse practitioners (NPs) and physician assistants (PAs) (Lowe et al., 2005). In many practices, NPs and PAs are used to increase the efficiency of physicians so more patients can be seen by a provider (either the physician or NP/PA) in a day. This staffing practice may, however, just be more common in practices in lower income neighborhoods (where reimbursements are lower, given higher Medicaid populations) and perhaps the true effect, low income, is the root cause of the frequent ED utilization—not the presence of PAs and NPs.

**Environmental Factors Impacting ED Utilization**

Policy and organizational processes are often a reflection of the environment in which they exist. As a result, emergency departments have been built for ease of access. EDs are often located in convenient locations—typically directly off major highways to ease access for emergency medical transportation. Emergency medical services typically transfer patients to the nearest hospital that is able to provide the proper level of care (not all hospitals or EDs can care for all types of cases—notably pediatric, trauma, and labor/delivery cases). Furthermore, hospitals are given special road signage, standardized across the United States (a rectangular blue sign with a white “H”). This is used to direct drivers to nearby hospitals. Even freestanding EDs are often located in convenient community locations—geared specifically to be easily accessible to the local community (Ferber & Becker, 1983). Given the ease of access, utilization of the ED becomes easier since they are prevalent and very easy to find.

While the ED may be easy to locate, the choice of whether or not to go to the ED is often more difficult. Given the inherent lack of in depth medical knowledge that most patients possess, it can sometimes be difficult to know whether or not one should go to the emergency department when experiencing concerning symptoms. In a survey of patients and ED physicians it was found that 86.5% of patients perceived their problems to be emergent, whereas 65.8% of emergency physicians felt the
patients were emergent (Hunt, DeHart, Allison, & Whitley, 1996). However, in the face of uncertainty, many patients adhere to the “better safe than sorry” adage and proceed to the ED. This is further exacerbated by the lack of primary care and urgent care resources in low-income neighborhoods where ED frequent users tend to reside (Yee, Lechner, & Boukus, 2013). In a survey of 100 ED frequent users, 77% of patients stated that the reason for their ED visit was because their problem was emergent and could only be addressed in a hospital or ED (Birmingham et al., 2017).

Cost of Care and Practical Implications of Caring for ED Frequent Users

As previously discussed, emergency room care is among the most expensive care that can be delivered in the outpatient realm. Given the frequency of ED utilization, ED frequent users accrue relatively high ED charges when their expenses are aggregated. As stated before, LaCalle and Rabin (2010) demonstrated that ED frequent users make 21-28% of ED visits per year. Using the Lee et al. (2013) estimate of the cost of ED care, if 21-28% of ED costs are attributed to ED frequent users (which I acknowledge, is not a perfect proxy, as discussed below), the result would be $28.6-$38.1 billion attributed to just ED frequent users. If the more conservative MEPS estimate of total ED cost is used, this total is $10.1-$13.5 billion. Unfortunately, no literature to my knowledge has calculated the population-wide cost of ED visits made by ED frequent users. One report from a South Carolina Public Health agency states, “visits by frequent users comprise 21% of all visits to EDs, 10% of all costs incurred in EDs, and 5% of patients in the ED” (South Carolina Public Health Institute, 2011).

Assuming all types of patients who use the ED have approximately equal costs is not a good practice, as is directly evidenced by the data from South Carolina (while ED frequent users make 21% of visits, they do not incur 21% of costs). An analysis by Ruger et al. (2004) demonstrates that ED costs vary depending on how many ED visits the patient makes per year. Table 4 is presented below from the Ruger et al. (2004) analysis. Those who make 20 or more ED visits per year have lower costs in every category than all other utilization groups. However, those in the 6-20 ED visits per year category have
the highest total costs out of all categories. This further evidences the heterogeneity of the ED frequent user population with respect to costs.

**Table 4: Differences in Costs by the Number of Annual ED Visits**

<table>
<thead>
<tr>
<th></th>
<th>1 Visit</th>
<th>2 Visits</th>
<th>3-5 Visits</th>
<th>6-20 Visits</th>
<th>&gt;20 Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length of stay (LOS) (inpatient days ± SE)†</strong></td>
<td>1.09 ± 0.02</td>
<td>1.19 ± 0.03</td>
<td>1.36 ± 0.03</td>
<td>1.30 ± 0.04</td>
<td>0.36 ± 0.05</td>
</tr>
<tr>
<td><strong>Costs (costs ± SE)†</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory</td>
<td>219.61 ± 6.83</td>
<td>212.13 ± 6.94</td>
<td>251.58 ± 10.93</td>
<td>224.64 ± 8.95</td>
<td>71.54 ± 6.79</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>247.65 ± 7.10</td>
<td>232.26 ± 8.97</td>
<td>266.69 ± 9.27</td>
<td>266.59 ± 15.85</td>
<td>110.57 ± 16.84</td>
</tr>
<tr>
<td>Radiology</td>
<td>208.57 ± 3.83</td>
<td>198.56 ± 4.35</td>
<td>194.91 ± 4.35</td>
<td>168.25 ± 6.79</td>
<td>76.87 ± 7.39</td>
</tr>
<tr>
<td>Catheterization</td>
<td>75.17 ± 4.67</td>
<td>74.73 ± 6.50</td>
<td>81.14 ± 6.87</td>
<td>72.92 ± 10.24</td>
<td>3.21 ± 6.21</td>
</tr>
<tr>
<td>Operating room</td>
<td>155.91 ± 6.15</td>
<td>120.23 ± 9.68</td>
<td>82.27 ± 5.66</td>
<td>60.15 ± 7.79</td>
<td>6.09 ± 5.11</td>
</tr>
<tr>
<td>Other Costs</td>
<td>591.69 ± 8.36</td>
<td>541.28 ± 10.26</td>
<td>567.49 ± 12.21</td>
<td>568.99 ± 17.69</td>
<td>321.61 ± 11.74</td>
</tr>
<tr>
<td>Total Costs</td>
<td>2360.80 ± 45.23</td>
<td>2220.57 ± 58.50</td>
<td>2437.62 ± 61.81</td>
<td>2294.33 ± 60.76</td>
<td>793.12 ± 62.85</td>
</tr>
</tbody>
</table>

*All figures are costs, not charges, and are reported in 2001 dollars.*
†Analysis performed at the visit level using analysis of variance done explicitly by linear regression with pairwise comparisons—all estimates corrected for multiple comparisons (with Bonferroni corrections), where applicable and adjusted for clustering within patient (with Huber-White sandwich estimators).

Footnoted pairs are significantly different from each other at the p < 0.05 level with Bonferroni correction for multiple comparisons and Huber-White correction for clustering within patients.

**Source:** Ruger et al (2014), Academic Emergency Medicine. Permissions granted from publisher.

A report published by the Congressional Research Service described the costly nature of ED frequent users (Heisler & Talyor, 2014). In this report the authors broke ED frequent users into three groups based on their utilization patterns—describing each group, how they contributed to expenses, and potential solutions. The first group called frequent users of non-emergent services in the ED were characterized by being relatively healthy, having primary care physicians, but having a lack of access to primary care after hours. They note that this population is costly to payers due to the higher costs and charges associated with receiving care in the ED—especially for care that could be equally well-treated elsewhere (Heisler & Talyor, 2014). The second group, coined “high-cost health system users”, tended to have more chronic conditions or substance use disorders. This group was determined to be expensive because of their especially high inpatient-utilization. Lastly—the group of most frequent ED users—which were characterized as having 10 or more ED visits per year. This group was found to be the least expensive because they are rarely admitted, despite high rates of disability and chronic disease (Heisler & Talyor, 2014). Given the differing group characteristics, and associated differences in costs—unique policies to reduce utilization and expenditure were suggested by Heisler and Taylor.
The Heisler and Talyor (2014) also noted that ED frequent users contribute to ED crowding, which is an indirect cost associated with ED frequent users. ED crowding is a costly problem because it often leads to nursing shortages which can sometimes only be filled with costly PRN staff. Furthermore, ED crowding is associated with lower provider satisfaction—leading staff nurses to leave—exacerbating the crowding issue (Boyle, Beniuk, Higginson, & Atkinson, 2012).

The potential for cost-savings is frequently discussed in the literature on ED frequent users. Many interventions have demonstrated cost-savings, although none of them have had randomly-assigned controls (all studies showing cost-savings had pre-post trial designs where patients served as their own controls). Despite the limitations with this study methodology, some pre-post cohort studies show decreases in costs, with one intervention demonstrating cost-savings of 37.5% (Raven, Doran, Kostrowski, Gillespie, & Elbel, 2011). Literature has repeatedly highlighted the potential for cost-savings to be generated if resources are dedicated to high-cost patients- like ED frequent users (Emeche, 2015; Institute of Medicine (US) Committee on Utilization Management, 1989; Johnson et al., 2015). The promise of cost-savings has yet to come to fruition in a randomized controlled trial. Jeffrey Brenner, the person held in high regard for his Hotspotter program in Camden, New Jersey, notes that in some cases, effective innovations are being developed to reduce ED reliance, but are not being shared with others—rather are being copyrighted or trademarked, and kept private within organizations looking to maintain their competitive advantage (Burns, 2014).

Hospitals and ED providers have worked to reduce the burden of ED frequent users on their EDs. Concerns over capacity management as well as financial solvency have created the desire to intervene with this population. Care plans, which are a plan of medical care that is often created by a multidisciplinary medical team who is familiar with the patient, are a common way to try to intervene with specific patients. One hospital recently implemented care plans for selected ED frequent users and reported saving $1.1 million as a result Sun (2015). Since this study did not have a control group and was
simply an observational study, it is not known if these expenditures would have been avoided naturally, without the intervention. ED frequent users tend to not be chronic, and their use naturally resolves itself within a few months according to Johnson et al. (2015). However, with the potential for great cost reductions, it is attractive to hospitals to explore utilization management programs—especially when care management resources (nurses and other extenders) already exist in the health system or hospital. A recent systematic review of interventions for ED frequent users shows that case management (which often involves the development of “care plans”) was the most frequently used tactic to intervene with ED frequent users, only one intervention was found to be cost-saving (which was an observational pre-post study where patients were exposed to an intervention, and their ED utilization and costs were subsequently measured (Soril et al., 2015; Stokes-Buzzelli, Peltzer-Jones, Martin, Ford, & Weise, 2010).

The evidence on the effectiveness of ED frequent user interventions is somewhat mixed, as previously discussed. Cohort studies tend to show better results in the reduction of ED visits as a result of intervention implementation than randomized controlled trials (Althaus et al., 2011; Soril et al., 2015). Johnson et al. (2015) and others have suggested that this is because ED frequent users often resolve on their own within a few months. The Soril et al. (2015) systematic review shows no interventions that were evaluated as RCTs decreased costs of care for ED frequent users, although one observational study did show decreased costs (Stokes-Buzzelli et al., 2010). The one RCT that did evaluate costs of care for ED frequent users showed an increase in costs over the study period (Shumway et al., 2008). Given the typically poor health status of ED frequent users; this should not be surprising, as it may take intensive medical intervention (in both the inpatient and outpatient side) over the short run to improve the health of this population. Despite the lack of evidence showing cost-savings, hospitals continue to intervene with this population—perhaps because of the cohort-style analyses that show visit reductions (and an assumption that reduced ED visits must mean reduced health care costs), or perhaps because of the logical appeal of intervening with a small, expensive
population to make a big impact on costs. In either case, data from RCTs does not support evidence of cost-savings (Althaus et al., 2011; Shumway et al., 2008; Soril et al., 2015).

The literature has largely deemed ED frequent users to be a costly group of patients. While some costs are preventable, it should be noted that not all of these costs are preventable or unreasonable, but they are, however, adding to the growing health expenditures observed in the United States. Not only does this group directly contribute to costs through their ED and subsequent inpatient visit charges, they also contribute to ED crowding, causing increased staffing costs. When ED crowding is studied in the context of ED frequent users, ED frequent users are often discussed as being equivalent to nonurgent ED users (Hoot & Aronsky, 2008). One study estimates that 55% of ED visits made by non-urgent ED using population would be appropriately treated in a primary care setting. Many experts, including John Billings—well-known for his contributions to primary care sensitive conditions in EDs—have noted that increased utilization of the ED for primary care sensitive conditions do not reflect poor decision making on the part of the patient, but rather, reflect the poor access to primary care available to that patient population (Billings et al., 2000b; Kellermann & Weinick, 2012). Characteristics of the ED itself may also be drivers of ED frequent user use, given that 63% of surveyed ED frequent users state they would prefer to have more after-hours healthcare options, outside of the ED (Birmingham et al., 2017). Given the state of increasing health expenditures in the United States, effective interventions need to be taken to stop the increase in health expenditures. While ED frequent users are a very small part of the population, it is a part of the population where opportunities exist to improve care processes and personal health behaviors that can lead to better health and subsequently reduced expenditures.

Creating Better Interventions by Targeting Homogeneous Groups

Johnson et al. (2015) argues that ED frequent users are a heterogeneous population, and that in order to effectively intervene and improve health to reduce utilization, patients must be grouped into homogeneous categories that are then aligned with appropriate, targeted interventions. Targeted and
subsequently tailored interventions have been shown to be more effective in achieving program goals, and have demonstrated cost-effectiveness (Aspinall et al., 2015; Glanz et al., 2002; Meropol et al., 2014; Noar et al., 2007). Increased effectiveness in interventions, meaning reduced healthcare utilization and associated expenditures, could lead to a potentially meaningful decrease in health care costs associated with the ED frequent user population. Krieg et al. (2016) specifically stated that there is “…a need to better identify these patients in order to target those who will benefit most from interventions adapted to their specific needs.” Effective interventions for ED frequent users have been documented in retrospective cohort studies, but the effectiveness diminishes significantly in randomized controlled trials (Althaus et al., 2011; Soril et al., 2015). Results in all types of study designs have not consistently been shown to reduce total health care costs, specifically there has been a lack of proof in randomized controlled trials (Althaus et al., 2011; Kumar & Klein, 2013; Shumway et al., 2008; Soril et al., 2015).

In the Johnson et al. (2015) study, the authors grouped “super-utilizers” (defined as those who had 3 or more inpatient admissions during a rolling 12-month period evaluated over two years, or who had both a serious mental health concern and two or more hospitalizations in the same period) into clinically relevant categories. The methodology relied on a qualitative method outlined by Lewis, Kirkham, Duncan, and Vaithianathan (2013), which sets forth a process whereby subgroups are identified a priori and then predictive models are constructed to predict membership in the subgroup. While this work was unlike any other that attempted to create “intervention ready” subgroups out of a population of high utilizing patients, its primary weakness lies in the fact that the authors decided a priori the subgroups in which super-utilizers could fall into. These somewhat arbitrarily identified groups may or may not be what drives the excess utilization of the hospital.

Two of the defined groups in Johnson et al. (2015) (“patients with multiple chronic diseases/other” and “individuals with serious mental health diagnoses”) account for over 80% of their super-utilizer population, and could still have a great deal of heterogeneity within the group. The groups are
based on clinical diagnoses that, by themselves, do not explain the excessive hospital usage (for example, not everyone with multiple comorbid conditions is a super utilizer), and does not help the policy-maker create interventions that will improve health or curb utilization. The Johnson et al. (2015) study also focused on “super-utilizers”, which are distinctly different from ED frequent utilizers. Super-utilizers are not well-defined, but traditionally have high rates of inpatient utilization, and ED usage is typically less of a focus for this population (Mann, 2013, July 23).

As previously discussed, the Camden Coalition used cluster analysis to identify their sub-groups based on a plot of the number of ED visits and the cost of ED and inpatient care combined (Camden Coalition of Healthcare Providers, 2014). Once the subgroups are identified, interventions are tailored to the unique needs of the subgroup. While this methodology is an improvement on others, it still assumes that the underlying reason for the high utilization is inherently related to differences in ED utilization. This assumption fails when the reason for the high ED utilization is not related to differences in ED utilization or costs. For example, if a lack of transportation was the real cause of high ED utilization for a subgroup of ED frequent users, and transportation is not a predictor in the model (in the case of the Camden Coalition—if transportation is not being plotted on the plane)—then the model will not isolate those with transportation needs into a single group. While transportation needs may be detected in a larger subgroup of ED frequent users—the transportation needs will not be as effectively targeted if those with that specific need are not uniquely identified.

Similar to the Johnson analysis, the Camden Coalition has a focus on super-utilizers, but they also identify ED frequent users-only in their cluster analyses. Most analyses that have attempted to create a typology of ED frequent users (not super-utilizers) have largely focused on differences in the number of ED visits per year (Billings & Raven, 2013; Heisler & Talyor, 2014; Ruger et al., 2004). Waldner, Raven, Lazar, and Pines (2014) argue that frequent ED use cannot be viewed in isolation because inpatient hospitalization is the primary cost driver in health care. Thus, an inclusion of inpatient
utilization is appropriate when considering ED frequent users and interventions to reduce their health care expenditures.

As of now, there is no standard typology that exists to group ED frequent users into meaningful categories around which interventions can be created. More research needs to be done to better classify this population into meaningful categories so that public health professionals can create interventions to improve the health of the population while reducing their overall health expenditures. Moving forward with a lack of typology is contrary to what is known to be effective in the health behavior literature. It is known that personal characteristics and environmental factors can alter the effects of interventions on health behaviors and health outcomes (Bandura, 1999; King et al., 2008; Noar et al., 2007). As such, understanding personal characteristics and environmental factors common among sub-groups of ED frequent users is necessary before delivering an intervention that attempts to change health behaviors.

There is not agreement within the literature on how health care administrators should solve the problem of ED frequent users. Some suggest interventions for ED frequent users should focus on chronic disease management (Vinton et al., 2014), another suggests the focus should be on mental health and substance abuse (Liu et al., 2012), and yet another suggests that aggressive social work is the solution (Sun, Burstin, & Brennan, 2003). There will likely be differences in the costs of leveraging the interventions listed above, given differences in staffing costs, which will impact the cost-effectiveness of such programs.

To further complicate matters, the literature does not agree on whom, within the ED frequent utilizer population, should be targeted (Newton & Lefebvre, 2015; Smulowitz et al., 2013). This issue, who should be targeted, needs to be addressed before interventions can be designed to effectively improve health and reduce ED utilization. Targeted interventions cannot be effectively leveraged if we do not first understand who we are targeting. This point cannot be stressed enough.
where healthcare expenditures are unsustainable, we cannot afford to spend money and time on interventions that are blindly trying to address a poorly defined population. By focusing limited resources on targeted subpopulations with tailored interventions, rather than universally delivering blanketed interventions, the probability of successfully improving outcomes and reducing utilization and costs increases.

The research outlined in this dissertation fills the aforementioned gap by establishing a typology of ED frequent users which takes into account inpatient utilization using a statistical method that does not require a priori decisions about what defines subgroups of ED frequent users. When paired with information on costs associated with each subgroup of ED frequent users, health care administrators can begin to make informed decisions about which groups to intervene with, based on the goals of the health system. This method answers questions about not only who the subgroups of ED frequent users are, but also sheds light on whom, within the population, should be targeted with interventions.
Chapter 3: Methods

The primary research question was whether or not there are homogeneous sub-groups within the population of ED frequent users. It was expected that sub-groups would exist, as the literature has stated that the ED frequent user population is heterogeneous (Billings & Raven, 2013; Johnson et al., 2015). Therefore, this analysis focused on defining and describing such subgroups of ED frequent users, and providing insight into which group would be associated with the greatest cost-savings if provided an effective intervention.

This is a retrospective, cross-sectional analysis of ED frequent users at the Summa Health System-Akron Campus Emergency Department. The hospital is a verified Level 1 Trauma Center by the American College of Surgeons. The Summa Health-Akron City Campus ED sees approximately 100,000 ED visits per year, and serves a primarily adult population (there is an emergency department specifically for children located approximately 1 mile away). The ED is located in Akron, Ohio which is a city located in the northeast part of Ohio, approximately 40 minutes south of Cleveland. Akron has approximately 200,000 inhabitants, a median age of 35.7, and is predominantly white (62%) and black (32%) (U.S. Census Bureau, 2010).

ED frequent users were included in the analysis if they made 4 or more ED visits in calendar year 2014, which is consistent with the standard literature definition of an ED frequent user as previously described. The analysis only included patients who were discharged from the emergency department—thus did not include those who left without treatment or left without being seen. While the ED is part of an adult-only hospital, those under the age of 18 are occasionally seen in the ED, often times prior to being transferred to another facility. Given the primarily adult-focused nature of this ED those patients seen at the ED under 18 years of age were excluded from the analysis.

It was hypothesized that differences in ED admission rate, primary clinical reason for visiting the ED, presence of chronic disease and/or mental health/substance abuse disorders, socioeconomic status (as
measured by having Medicaid insurance and living in a low-income zip code), 30-day readmission rate, illness severity (as measured by age-adjusted Charlson co-morbidity index), degree to which ED use is chronic among ED frequent users, and demographics (age, sex, race) would explain the differences between the latent classes.

This project was evaluated by the Summa Health System Institutional Review Board and was granted approval. Additionally, the Institutional Review Board at Kent State approved the project, but the IRB at Summa Health was the official IRB of record.

Data Sources

Data was collected from an administrative database populated with selected data from the electronic medical record at Summa Health System- Akron Campus. This was supplemented with data from the accounting database that generates bills for hospital-based visits. Additionally, data was collected from a quality improvement database that maintains information on 30-day readmissions. All three databases are updated and maintained on a regular basis for quality-monitoring and billing purposes. The administrative and quality datasets are maintained by the quality division while the finance and accounting department maintains the billing database. Data is collected continuously.

The patient medical record number was used to link data together across databases. The medical record is a reliable key to use across databases, since its accuracy is needed for billing purposes. However, some loss of information was expected as some medical records would not link across all three databases. This is described further in the following chapter.

Once ED frequent users were identified using 2014 data, the administrative database was queried to see if the frequent ED users presented to the ED again as frequent ED users in full year 2015. The purpose of this was to see how many frequent ED users in 2014 were still frequent ED users in 2015.

Variables collected from the datasets included: visit encounter number (row identifier), medical record number, sociodemographics (age, sex, insurer, zip code where patient resides), total costs,
diagnosis codes, presence of inpatient admission or observation stay following an ED visit, and whether or not the inpatient visit resulted in a 30-day readmission, and the number of ED visits made in the following year (2015), as well as associated total costs (fixed and variable).

The data primarily came from an administrative dataset that provides visit-level data. However, the statistical analysis (Latent Class Analysis (LCA)) required patient-level data to group patients into homogeneous categories. This required some data manipulation to construct the dataset for LCA which is described below.

**Variables to be used in LCA**

**Number of ED visits:** The number of ED visits was captured from the visit-level administrative dataset. The number of ED visits was counted by summing the count of ED visits made to the Akron Campus by a single individual in 2014 and 2015 (to identify chronic frequent ED users). In order to use this variable in the LCA, the variable needed to be transformed into a categorical variable. The categories were: 4-7 ED visits/year, 8-12 ED visits/year, and 13 or more ED visits/year.

**High frequency ED user:** A measure of very frequent ED use was captured using the administrative dataset. Consistent with prior studies, a high frequency ED user was defined as one who makes 10 or more ED visits in 12-month period (DeHaven et al., 2012; Spillane et al., 1997; Vinton et al., 2014).

**High frequency hospital admission and observation visitor:** The number of hospital admissions and observation visits will be counted by summing the count of the inpatient hospital and observation admissions for a single individual in 2014. Both inpatient hospital stays and observation visits will be counted in this single metric. This will be a binary variable representing high frequency inpatient and observation utilizers. Using the work by Jiang, Weiss, Barrett, and Sheng (2015) as a guide, those who made 4 or more inpatient or observation stays were identified as high frequency inpatient/observation utilizers, and those who made less than 4 inpatient or observation stays will not be identified as such.
**Inpatient admittance as a percent of ED visits:** A measure of how many ED visits resulted in inpatient hospitalizations was also created using data from the administrative dataset for 2014. This was the number of inpatient admits divided by the number of ED visits. This was a binary variable taking either a value of 1 (<50% of ED visits result in inpatient admission) or a value of 0 (≥50% of ED visits result in an inpatient admission).

**Primary reason for ED visit:** The primary reason for the ED visit was categorized. In the LCA, only the primary diagnosis code was used to identify the reason for the ED visit. The primary diagnosis code typically represents the primary reason for the visit. Given that ED frequent users have multiple ED visits, the visit-level data was tabulated to determine the most frequent primary diagnosis code for each individual. The primary ICD-9 diagnosis code for each visit (for each person) was grouped into the following standard ICD-9 categories. Then, the most frequently occurring category for each individual was selected to represent the primary reason for individual’s ED visits. When there was not a most frequent category, they were assigned a primary reason of “all different reasons”.
Table 5: Primary ICD-9 Diagnosis Code Categories

<table>
<thead>
<tr>
<th>ICD 9 codes</th>
<th>ICD-9 Chapter Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>001-139</td>
<td>Infectious And Parasitic Diseases</td>
</tr>
<tr>
<td>140-239</td>
<td>Neoplasms</td>
</tr>
<tr>
<td>240-279</td>
<td>Endocrine, Nutritional And Metabolic Diseases, And Immunity Disorders</td>
</tr>
<tr>
<td>280-289</td>
<td>Diseases Of The Blood And Blood-Forming Organs</td>
</tr>
<tr>
<td>290-319</td>
<td>Mental Disorders</td>
</tr>
<tr>
<td>320-389</td>
<td>Diseases Of The Nervous System And Sense Organs</td>
</tr>
<tr>
<td>390-459</td>
<td>Diseases Of The Circulatory System</td>
</tr>
<tr>
<td>460-519</td>
<td>Diseases Of The Respiratory System</td>
</tr>
<tr>
<td>520-579</td>
<td>Diseases Of The Digestive System</td>
</tr>
<tr>
<td>580-629</td>
<td>Diseases Of The Genitourinary System</td>
</tr>
<tr>
<td>630-679</td>
<td>Complications Of Pregnancy, Childbirth, And The Puerperium</td>
</tr>
<tr>
<td>680-709</td>
<td>Diseases Of The Skin And Subcutaneous Tissue</td>
</tr>
<tr>
<td>710-739</td>
<td>Diseases Of The Musculoskeletal System And Connective Tissue</td>
</tr>
<tr>
<td>740-759</td>
<td>Congenital Anomalies</td>
</tr>
<tr>
<td>760-779</td>
<td>Certain Conditions Originating In The Perinatal Period</td>
</tr>
<tr>
<td>780-799</td>
<td>Symptoms, Signs, And Ill-Defined Conditions</td>
</tr>
<tr>
<td>800-999</td>
<td>Injury And Poisoning</td>
</tr>
<tr>
<td>V01-V91</td>
<td>Supplementary Classification Of Factors Influencing Health Status And Contact With Health Services</td>
</tr>
<tr>
<td>E000-E999</td>
<td>Supplementary Classification Of External Causes Of Injury And Poisoning</td>
</tr>
</tbody>
</table>

**Presence of mental health diagnosis:** A binary variable indicating the presence of mental health problem was created. The following table contains the ICD-9 codes that were used to identify mental health diagnoses. If the individual had one of the following diagnosis codes as a primary discharge diagnosis code in 2014, they were identified as having a mental health diagnosis.

| Mental Health: Psychoses and Depression | 295-299, 300.4, 309.1, 311 |

**Presence of a substance abuse disorder (drug and alcohol):** A binary variable indicating the presence of a substance abuse disorder was created. The following table contains the ICD-9 codes that were used to identify a substance abuse disorder. If the individual had one of the following diagnosis codes as a primary discharge diagnosis code in 2014, they were identified as having a substance abuse disorder.
**Substance abuse disorders (drug and alcohol)** | 291.xx, 292.xx, 303.xx, 304.xx, 305.xx

**Presence of chronic diseases:** This is a discrete variable with 4 levels indicating the number of chronic diseases a frequent ED user had documented in the medical record. All 26 diagnosis code positions on the first ED visit of 2014 for each individual were evaluated and coded. The categories will be: 0- no chronic diseases, 1-2 chronic diseases, 3-5 chronic diseases, and 6 or more. Given that the data is from 2014, ICD-9 codes will be used to identify the following chronic conditions. These 20 chronic conditions were identified to create a standard list of chronic condition to standardize research practices by the Office of the Assistant Secretary to Health (OASH) within the Department of Health and Human Services (HHS) (Goodman, Posner, Huang, Parekh, & Koh, 2013).
Table 6: Chronic Disease ICD-9 Definitions

<table>
<thead>
<tr>
<th>Disease</th>
<th>ICD-9 Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>401.0, 401.1, 401.9, 402.00, 402.01, 402.10, 402.11, 402.90, 402.91, 403.00, 403.01, 403.10, 403.11, 403.90, 403.91, 404.00, 404.01, 404.02, 404.03, 404.10, 404.11, 404.12, 404.13, 404.90, 404.91, 404.92, 404.93, 405.01, 405.09, 405.11, 405.19, 405.91, 405.99, 362.11, 437.2</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>398.91, 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 404.93, 404.94, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.49</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>410.00, 410.01, 410.02, 410.10, 410.11, 410.12, 410.20, 410.21, 410.22, 410.30, 410.31, 410.32, 410.40, 410.41, 410.42, 410.50, 410.51, 410.52, 410.60, 410.61, 410.62, 410.70, 410.71, 410.72, 410.80, 410.81, 410.82, 410.90, 410.91, 410.92, 411.0, 411.1, 411.81, 411.89, 412, 413.0, 413.1, 413.9, 414.00, 414.01, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 414.12, 414.2, 414.3, 414.8, 414.9</td>
</tr>
<tr>
<td>Cardiac arrhythmias</td>
<td>427.31</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>272.0, 272.1, 272.2, 272.3, 272.4</td>
</tr>
<tr>
<td>Stroke</td>
<td>430, 431, 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.00, 434.01, 434.10, 434.11, 434.90, 434.91, 435.0, 435.1, 435.3, 435.8, 435.9, 436, 997.02</td>
</tr>
<tr>
<td>Arthritis</td>
<td>714.0, 714.1, 714.2, 714.30, 714.31, 714.32, 714.33, 715.00, 715.04, 715.09, 715.10, 715.11, 715.12, 715.13, 715.14, 715.15, 715.16, 715.17, 715.18, 715.20, 715.21, 715.22, 715.23, 715.24, 715.25, 715.26, 715.27, 715.28, 715.30, 715.31, 715.32, 715.33, 715.34, 715.35, 715.36, 715.37, 715.38, 715.80, 715.89, 715.90, 715.91, 715.92, 715.93, 715.94, 715.95, 715.96, 715.97, 715.98, 720.0, 721.0, 721.1, 721.2, 721.3, 721.90, 721.91</td>
</tr>
<tr>
<td>Asthma</td>
<td>493.00, 493.01, 493.02, 493.10, 493.11, 493.12, 493.20, 493.21, 493.22, 493.81, 493.82, 493.90, 493.91, 493.92</td>
</tr>
<tr>
<td>Autism spectrum disorder</td>
<td>*Included in mental health grouping- will use previously listed ICD-9 codes for mental health ** OASH Does not provide specific ICD-9 codes for Autism Spectrum Disorder</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>016.00, 016.01, 016.02, 016.03, 016.04, 016.05, 016.06, 095.4, 189.0, 189.9, 223.0, 236.91, 249.40, 249.41, 250.40, 250.41, 250.42, 250.43, 271.4, 274.10, 283.11, 403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 440.1, 442.1, 572.4, 580.0, 580.4, 580.81, 580.89, 580.9, 581.0, 581.1, 581.2, 581.3, 581.81, 581.89, 581.9, 582.0, 582.1, 582.2, 582.4, 582.81, 582.89, 582.9, 583.0, 583.1, 583.2, 583.4, 583.6, 583.7, 583.81, 583.9, 584.5, 584.6, 584.7, 584.8, 584.9, 585, 585.1, 585.2, 585.3, 585.4, 585.5, 585.6, 585.9, 586, 587, 588.0, 588.1, 588.81, 588.9, 591, 753.12, 753.13, 753.14, 753.15, 753.16, 753.17, 753.18, 753.19, 753.20, 753.21, 753.22, 753.23, 753.29, 794.4</td>
</tr>
</tbody>
</table>
Table 6: Continued

<table>
<thead>
<tr>
<th>Disease</th>
<th>ICD-9 codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Obstructive Pulmonary Disease (COPD)</td>
<td>490, 491.0, 491.1, 491.20, 491.21, 491.22, 491.8, 491.9, 492.0, 492.8, 494.0, 494.1, 496</td>
</tr>
<tr>
<td>Dementia (including Alzheimer’s and other senile dementias)</td>
<td>331.0, 331.1, 331.11, 331.19, 331.2, 331.7, 290.0, 290.10, 290.11, 290.12, 290.13, 290.20, 290.21, 290.3, 290.40, 290.41, 290.42, 290.43, 294.0, 294.10, 294.11, 294.8, 797</td>
</tr>
<tr>
<td>Depression</td>
<td>296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 296.51, 296.52, 296.53, 296.54, 296.55, 296.56, 296.60, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.89, 298.0, 300.4, 309.1, 311</td>
</tr>
<tr>
<td>Diabetes</td>
<td>249.00, 249.01, 249.10, 249.11, 249.20, 249.21, 249.30, 249.31, 249.40, 249.41, 249.50, 249.51, 249.60, 249.61, 249.70, 249.71, 249.80, 249.81, 249.90, 249.91, 250.00, 250.01, 250.02, 250.03, 250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93, 357.2, 362.01, 362.02, 366.41</td>
</tr>
<tr>
<td>Hepatitis</td>
<td>573.3 ** OASH does not provide ICD-9 code for Hepatitis. This code (573.3) is the ICD-9 code for Hepatitis, unspecified.</td>
</tr>
<tr>
<td>Human Immunodeficiency Virus (HIV)</td>
<td>042.00 ** OASH does not provide ICD-9 code for HIV. This code (042.00) is the ICD-9 code for HIV.</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>733.00, 733.01, 733.02, 733.03, 733.09</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>*Included in mental health grouping- will use previously listed ICD-9 codes for mental health disorders. ** OASH Does not provide specific ICD-9 codes for Schizophrenia</td>
</tr>
<tr>
<td>Substance abuse disorders (drug and alcohol)</td>
<td>*Included in mental health grouping ** OASH Does not provide specific ICD-9 codes for Substance abuse disorders. Will use previously listed substance abuse disorder ICD-9 codes.</td>
</tr>
</tbody>
</table>

**Age-adjusted Charlson Comorbidity Index**: The age-adjusted Charlson Comorbidity index (AACCI) was calculated for the first ED visit the individual made in 2014. This is a validated metric that classifies comorbidities and predicts 1-year mortality (Charlson, Pompei, Ales, & MacKenzie, 1987). The original Charlson Comorbidity index has been updated overtime, and a more recent, validated version adjusts for the effect of age (Yang, Chen, Hsu, Chang, & Lee, 2015). In this analysis, the AACCI was used to
quantify the degree of morbidity a patient experiences. The AACCI takes into account the entire set of diagnosis codes for an ED visit—thus capturing more of the individual complexity. The AACCI was calculated based on data from the last ED visit for 2014.

The following table provides ICD-9 codes for comorbidities defined by the Charlson Comorbidity algorithm (Quan et al., 2005). If the patient medical record indicates that they have any of the following diagnoses, the listed number of points are accrued. The number of points is the Charlson Comorbidity score—where a higher score indicates greater probability of mortality, and the higher expected resource utilization. To age-adjust the score, 1 point is accrued for every decade beyond 40 years of age (for example, 50-59 years = 1 point, 60-69 years = 2 points). This measure has been validated as a mean to evaluate the risk of mortality (Charlson, Szatrowski, Peterson, & Gold, 1994).
### Table 7: Charlson Comorbidity Algorithm

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>ICD-9 Code*</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial Infarction</td>
<td>410.x, 412.x</td>
<td>1</td>
</tr>
<tr>
<td>Congestive Heart Failure</td>
<td>398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 425.4-425.9, 428.x</td>
<td>1</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>093.0, 437.3, 440.x, 441.x, 443.1-443.9, 47.1, 557.1, 557.9, V43.4</td>
<td>1</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>362.34, 430.x-438.x</td>
<td>1</td>
</tr>
<tr>
<td>Dementia</td>
<td>290.x, 294.1, 331.2</td>
<td>1</td>
</tr>
<tr>
<td>Chronic Pulmonary disease</td>
<td>416.8, 416.9, 490.x-505.x, 506.4, 508.1, 508.8</td>
<td>1</td>
</tr>
<tr>
<td>Rheumatic disease</td>
<td>446.5, 710.0-714.8, 725.x</td>
<td>1</td>
</tr>
<tr>
<td>Peptic Ulcer disease</td>
<td>531.x-534.x</td>
<td>1</td>
</tr>
<tr>
<td>Mild liver disease</td>
<td>070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 070.6, 070.9, 570.x, 5710.x, 573.3, 573.4, 573.8, 573.9, V42.7</td>
<td>1</td>
</tr>
<tr>
<td>Diabetes without chronic complication(s)</td>
<td>250.0-250.3, 250.8, 250.9</td>
<td>1</td>
</tr>
<tr>
<td>Diabetes with chronic complication(s)</td>
<td>250.4-250.7</td>
<td>2</td>
</tr>
<tr>
<td>Hemiplegia or paraplegia</td>
<td>334.1, 342.x, 343.x, 344.0-344.6, 344.9</td>
<td>2</td>
</tr>
<tr>
<td>Renal disease</td>
<td>403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 582.x, 583.0-583.7, 585.x, 586.x, 588.0, V42.0, V45.1, V56.x</td>
<td>2</td>
</tr>
<tr>
<td>Any malignancy: including lymphoma and leukemia, except malignant neoplasm of skin</td>
<td>140.x-172.x, 174.x-195.8, 200.x-208.x, 238.6</td>
<td>2</td>
</tr>
<tr>
<td>Moderate or severe liver disease</td>
<td>456.0-456.2, 572.2-572.8</td>
<td>3</td>
</tr>
<tr>
<td>Metastatic solid tumor</td>
<td>196.x-199.x</td>
<td>6</td>
</tr>
<tr>
<td>AIDS/ HIV</td>
<td>042.x-044.x</td>
<td>6</td>
</tr>
</tbody>
</table>

**Zip code:** Zip code of residence was captured from the administrative dataset. This was used as a proxy for median income. Median income level data comes from the Institute for Social Research and the University of Michigan, where data from the 2005-2009 American Community Survey was compiled at the zip code level.
**Payer:** Payer (insurer) was captured from the administrative dataset. This represents whether or not the patient had insurance, as well as the type of insurer (Medicare, Medicaid, Private, No-insurance/ self-pay).

**Age:** Age in years was captured from the administrative dataset. Age is a calculated variable that subtracts the date of birth from the date of the ED visit.

**Sex:** Sex was captured from the administrative dataset. Sex can only be captured as male or female in the database, and is self-identified by the patient.

**Race/ethnicity:** Race/ethnicity was captured from the administrative dataset. The dataset uses a 5-level definition: white, black, Asian, Hispanic, other. Only one category can be assigned to an individual—but if the individual self-identifies as more than one category, they are classified as “other” (to indicate mixed race/ethnicity).

**Chronic ED frequent user:** A chronic ED frequent user will be defined as someone who was an ED frequent user in both 2014 and 2015. This is a binary variable indicating whether or not the individual is classified as an ED frequent user in both years.

**Number of admissions that resulted in 30-day readmissions in 2013:** The number of admissions that resulted in a readmission was captured from the quality dataset, which provides information on 30-day all cause readmissions.

**Statistical Analysis**

Rather than using a qualitative approach to group ED frequent users into categories where subconscious biases can enter into the analysis, a statistical methodology was used to allow the data to predict which individuals fall into which subgroup, given a set of variables. This approach, called latent class analysis (LCA), uses patient-level data to predict class membership, and “disaggregates heterogeneous patterns, fostering understanding of risk factors and outcomes related to distinct subpopulations” (Sacco, Bucholz, & Spitznagel, 2009). Latent class analysis is a type of latent variable analysis...
model which is used to measure variables that cannot be directly observed (The Methodology Center at Penn State, 2012). This methodology has been used to create meaningful subgroupings of adults using alcohol (Sacco et al., 2009), drug adherence (Ahn et al., 2008) and cigarette smokers (Niu, Luo, Silenzio, Xiao, & Tian, 2015). Collins and Lanza (2010) write,

The overall objective of performing a latent class analysis on a set of variables is to arrive at an array of latent classes that represent the response patterns in the data, and to provide a sense of the prevalence of each latent class and the amount of error associated with each variable in measuring these latent classes (Collins & Lanza, 2010).

LCA describes how patterns of multiple risk factors impact individuals. This is especially useful in the frequent ED user population. Using the ED with high frequency is not associated with only a single factor (for example, having diabetes, or living in a low-income neighborhood) — rather high ED utilization is associated with many characteristics as previously described in Chapter 2. LCA helps to determine patterns that occur between characteristics and across individuals. This makes it possible to target tailored interventions to the most appropriate group of people (The Methodology Center at Pennsylvania State University, 2016). Essentially, latent class analysis helps to separate the signal (latent classes) from the noise (error).

Using LCA to group the population of ED frequent users into subpopulations was the first step in the analysis. Multiple studies have concluded that the ED frequent user population is heterogeneous and ripe for the development of a meaningful typology of ED frequent users (Billings & Raven, 2013; Camden Coalition of Healthcare Providers, 2014; Johnson et al., 2015). Unlike similar methodologies, such as clustering or factor analysis, LCA assigns a probability of sub-group membership to each individual—rather than assigning each individual to a certain group, as in clustering. LCA examines differences in categorical variables of individuals, whereas factor analysis is used for understanding the correlations between continuous variables associated with individuals, similar to latent profile analysis (Hoijtink, 2001). For the purpose of this project, most of the predictor variables were categorical (for example, presence of absence of substance use disorder, presence of a chronic disease, ACCI score,
payer, zip code, etc.), thus neither factor analysis nor latent profile analysis were an appropriate methodology. A few variables needed for the LCA were count variables and were transformed into categorical variables. Given that the majority of variables are categorical, and the few remaining variables could be transformed into categorical variables, LCA was the most appropriate methodology to use.

**Model Fit and Model Selection**

To determine which model offered the best fit, both absolute and relative model fit criteria were evaluated. Absolute model fit was determined by evaluating the $G^2$ likelihood ratio fit statistic. A rule of thumb from Collins and Lanza (2010) is that the $G^2$ statistic should be less than the degrees of freedom. Relative model fit was evaluated by considering the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), corrected Akaike Information Criterion (CAIC), and sample size adjusted Bayesian information criterion (adj BIC). In all four of these relative model fit statistics, lower values indicate better relative model fit. Entropy statistics were also examined. Entropy closer to 1 indicates better latent class classification and improved model fit (Hruska et al 2014). The purpose of looking at multiple models and minimizing the information criteria is to balance model fit with parsimony. Parsimonious models have strong explanatory power, but achieve it with as few predictor variables as needed. More variables will generally lead to greater model fit, however, adding too many variables to the model will lead to “over-fitting”, and limiting the model’s ability to generalize to the greater population (beyond the sample set). Thus, there was a focus on creating a parsimonious model.

**Examination of Grouping Variables and Covariates**

Once the model was determined, grouping variables were evaluated followed by an assessment of covariates as in Lanza, Collins, Lemmon, and Schafer (2007). Gender was evaluated as a grouping variable. Adding a grouping variable to the LCA model tests whether or not the latent classes are
invariant with respect to the grouping variable. If the classes are invariant, it means that there is an equal meaning of the variable across latent classes.

Age, socioeconomic status (SES, as measured by the median income in zip code being above 200% of the federal poverty level), and very high ED utilization were assessed as covariates. According to Collins and Lanza (2010), introducing covariates into a latent class model allows for a greater understanding as to which characteristics predict membership in the various latent classes. Including covariates in the model can help establish the naming conventions for the latent classes, and help produce an overall understanding of the meanings of each group.

**Group Assignment**

Once the best model has been identified, the number of classes has been determined, and grouping and covariates have been evaluated, patients will be assigned to a latent class based on their probabilities of group membership. The highest probability will indicate which group the individual is assigned to, which is done automatically in the software. The latent class analysis will be conducted in SAS using PROC LCA as developed at The Methodology Center, Pennsylvania State University.

To further determine which factors were associated with subgroup or class membership, the latent class analysis results were analyzed. The SAS PROC LCA results produced a tabulation of the percentage of people within the sub-group that had each identified variable. This is the information helped to determine how to give meaningful names to the groups. Additionally, a group of emergency physicians from Summa Health- Akron Campus were consulted on how to name the subgroups, given group characteristics and their expertise in emergency medicine.

**Cost Analysis**

To determine which sub-group has the highest costs to the organization, the associated costs for each visit made by the individuals in each group was be tabulated. The costs that were evaluated were total costs—including both fixed and variable costs from the accounting dataset. The additive total for
each group was calculated and compared across groups to determine which group was the highest-cost group. The highest cost-group was determined, as well as the group with the average highest cost-per-person within the group. The average cost per person was be calculated by dividing the total cost for the group by the number of patients assigned to the group. These results were evaluated to determine which group(s) to recommend to the health system for intervention.
Chapter 4: Data Analysis

Data was extracted from the three administrative data systems at Summa Health, as previously described, and according to the approved Institutional Review Board application. Data on 2014 emergency department visits was examined from Summa Health System- Akron Campus (including the Green and Medina freestanding emergency departments, which are considered a part of the Akron Campus). A total of 123,594 ED visits were made by 70,959 people to the aforementioned locations in 2014. Subsequently, 5,814 people were identified as ED frequent users (defined as those making four or more ED visits in 2014). Eighty-three (83) people were excluded because they were less than 18 years of age, thus met exclusion criteria for the study. The remaining 5,731 individuals were the sample used for analysis.

A histogram plot of the number of ED visits made by eligible frequent ED users is picture below in Figure 4. The histogram shows that most ED frequent users made relatively smaller numbers of ED visits, but a small number of individuals made very high numbers of ED visits (the maximum number of ED visits made by an individual was 89 visits).

Figure 4: Histogram of 2014 ED Frequent User Visits
As previously mentioned, the data was matched across three different datasets. First, the majority came from an administrative dataset which was used to define the ED frequent users, and to determine their characteristics. Next, their 30-day readmission rates were extracted from a quality dataset using the patient medical record number to match patients across the two datasets. In this dataset, all 30-day readmissions were downloaded for 2014 and then the medical record number was used to match ED frequent users who also had all-cause 30-day readmissions in 2014. One-thousand sixty-five (1,065) ED frequent users were found to have at least one 30-day readmission in 2014 (Minimum 1: Maximum: 14, Interquartile range (IQR): 1-2 readmissions) out of all 5,731 (or, 18.6% of the identified, eligible ED frequent user population).

Next, full cost data was extracted from an accounting dataset. Full costs are the most comprehensive cost that is collected by the health system- and represents both fixed and variable costs associated with the ED visit (and subsequent inpatient stay, if applicable). The ED costs are not able to be separated from the inpatient costs, so were considered together. Of the 5,731 ED frequent user medical record numbers, 5451 (95%) were matched in the accounting dataset.

Once the data was assembled in the analytic dataset per the data definitions prescribed in the methods section, descriptive statistics were generated in SAS version 9.3 (Cary, NC). The data was imported into SAS and it was ensured that the proper number of subjects were read into the software (n=5,731). Descriptive statistics were generated, and are presented below. Table 8 displays descriptive statistics for the continuous and count variables. Both the counts of inpatient and observation visits and the count of 30-day readmissions are very skewed, with interquartile ranges of 0-2 and 0-1, respectively, demonstrating that the vast majority of individuals had very few inpatient, observation, and 30-day readmissions visits.
Table 8: Continuous and Count Descriptive Statistics of the ED Frequent User Population (n=5,731)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
<th>IQR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ED Visits</td>
<td>6.24</td>
<td>4.13</td>
<td>5</td>
<td>4</td>
<td>89</td>
<td>4-7</td>
</tr>
<tr>
<td>Number of inpatient &amp;</td>
<td>1.46</td>
<td>2.07</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>0-2</td>
</tr>
<tr>
<td>observation Visits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of 30-day readmissions</td>
<td>0.51</td>
<td>1.04</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>0-1</td>
</tr>
<tr>
<td>Median income for zip code</td>
<td>$40,489</td>
<td>$15,384</td>
<td>$36,270</td>
<td>$13,015</td>
<td>$112,530</td>
<td>$30,958-46,909</td>
</tr>
<tr>
<td>Age (years)</td>
<td>46.89</td>
<td>19.69</td>
<td>44</td>
<td>18</td>
<td>101</td>
<td>44-60</td>
</tr>
</tbody>
</table>

Table 9 displays demographic categorical descriptive variables. The majority of the population is white, female, and insured. The utilization data demonstrates that a minority of frequent ED users (29.80%) are chronic ED users (four or more ED visits in both 2014 and 2015). Few made 10 or more ED visits in 2014 (18.70%) and even fewer (14.60%) made 4 or more inpatient or observation visits.
Table 9 Categorical Demographic Descriptive Variables (n=5,731)

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>2047</td>
<td>35.7%</td>
</tr>
<tr>
<td>White</td>
<td>3531</td>
<td>61.6%</td>
</tr>
<tr>
<td>Other</td>
<td>153</td>
<td>2.7%</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2297</td>
<td>40.0%</td>
</tr>
<tr>
<td>Female</td>
<td>3434</td>
<td>60.0%</td>
</tr>
<tr>
<td><strong>Payer Category</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicare</td>
<td>1696</td>
<td>29.6%</td>
</tr>
<tr>
<td>Medicaid</td>
<td>2504</td>
<td>43.7%</td>
</tr>
<tr>
<td>Commercial (private)</td>
<td>769</td>
<td>13.4%</td>
</tr>
<tr>
<td>Self-pay</td>
<td>762</td>
<td>13.3%</td>
</tr>
<tr>
<td><strong>Chronic ED Frequent User</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1709</td>
<td>29.8%</td>
</tr>
<tr>
<td>No</td>
<td>4022</td>
<td>70.2%</td>
</tr>
<tr>
<td><strong>High Inpatient and Observation Visitors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Made 4 + IP/OBS visits in 2014</td>
<td>837</td>
<td>14.6%</td>
</tr>
<tr>
<td>Made &lt; 4 IP/OBS visits in 2014</td>
<td>4894</td>
<td>85.4%</td>
</tr>
<tr>
<td><strong>High Frequency User</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Made 10 + ED visits in 2014</td>
<td>1073</td>
<td>18.7%</td>
</tr>
<tr>
<td>Made &lt; 10 ED visits in 2014</td>
<td>4658</td>
<td>81.3%</td>
</tr>
<tr>
<td><strong>ED to Inpatient admittance percentage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 50% of ED visits results in IP admit</td>
<td>4370</td>
<td>76.3%</td>
</tr>
<tr>
<td>50%+ of ED visits result in an IP admission</td>
<td>1361</td>
<td>23.8%</td>
</tr>
<tr>
<td><strong>30-day readmission category</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 readmissions</td>
<td>1915</td>
<td>70.6%</td>
</tr>
<tr>
<td>1 30-day readmission</td>
<td>479</td>
<td>17.7%</td>
</tr>
<tr>
<td>2-3 30-day readmissions</td>
<td>251</td>
<td>9.3%</td>
</tr>
<tr>
<td>4+ 30-day readmissions</td>
<td>66</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

Clinical descriptive data is provided in Table 10. The vast majority of individuals had a Charlson Comorbidity Index of 0 (96.90%), indicating this population did not meet the Charlson criteria for comorbidities. Relatively few ED frequent users had documented substance use and mental health disorders (in the primary diagnosis position), at 7.1% and 8.8%, respectively. At least one chronic disease was coded for 46.5% of ED frequent users at their last ED visit of 2014. ED frequent users presented for
a variety of reasons, but signs, symptoms, and ill-defined conditions were the most common reason patients came to the ED.

Table 10 Categorical Clinically Relevant Descriptive Variables (n=5,731)

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charlson Comorbidity Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score = 0</td>
<td>5556</td>
<td>96.9%</td>
</tr>
<tr>
<td>Score ≥ 1</td>
<td>175</td>
<td>3.1%</td>
</tr>
<tr>
<td>Age-adjusted Charlson Comorbidity Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score = 0</td>
<td>3268</td>
<td>57.0%</td>
</tr>
<tr>
<td>Score ≥ 1</td>
<td>2463</td>
<td>43.0%</td>
</tr>
<tr>
<td>Presence of Substance Abuse Disorder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>407</td>
<td>7.1%</td>
</tr>
<tr>
<td>No</td>
<td>5324</td>
<td>92.9%</td>
</tr>
<tr>
<td>Presence of Mental Health Disorder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>506</td>
<td>8.8%</td>
</tr>
<tr>
<td>No</td>
<td>5225</td>
<td>91.2%</td>
</tr>
<tr>
<td>Chronic Disease Categories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 Chronic diseases</td>
<td>3069</td>
<td>53.6%</td>
</tr>
<tr>
<td>1-2 Chronic diseases</td>
<td>1873</td>
<td>32.7%</td>
</tr>
<tr>
<td>3-5 Chronic diseases</td>
<td>720</td>
<td>12.6%</td>
</tr>
<tr>
<td>6+ Chronic diseases</td>
<td>69</td>
<td>1.2%</td>
</tr>
<tr>
<td>Primary reason for ED Visits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All different reasons</td>
<td>605</td>
<td>10.6%</td>
</tr>
<tr>
<td>Complications Of Pregnancy, Childbirth, And The Puerperium</td>
<td>186</td>
<td>3.3%</td>
</tr>
<tr>
<td>Diseases Of The Blood And Blood-Forming Organs</td>
<td>30</td>
<td>0.5%</td>
</tr>
<tr>
<td>Diseases Of The Circulatory System</td>
<td>249</td>
<td>4.3%</td>
</tr>
<tr>
<td>Diseases Of The Digestive System</td>
<td>301</td>
<td>5.3%</td>
</tr>
<tr>
<td>Diseases Of The Genitourinary System</td>
<td>259</td>
<td>4.5%</td>
</tr>
<tr>
<td>Diseases Of The Musculoskeletal System And Connective Tissue</td>
<td>403</td>
<td>7.0%</td>
</tr>
<tr>
<td>Diseases Of The Nervous System And Sense Organs</td>
<td>125</td>
<td>2.2%</td>
</tr>
<tr>
<td>Diseases Of The Respiratory System</td>
<td>437</td>
<td>7.6%</td>
</tr>
<tr>
<td>Diseases Of The Skin And Subcutaneous Tissue</td>
<td>151</td>
<td>2.6%</td>
</tr>
<tr>
<td>Endocrine, Nutritional And Metabolic Diseases, And Immunity</td>
<td>103</td>
<td>1.8%</td>
</tr>
<tr>
<td>Factors influencing health status (V-Code)</td>
<td>49</td>
<td>0.9%</td>
</tr>
<tr>
<td>Infectious And Parasitic Diseases</td>
<td>85</td>
<td>1.5%</td>
</tr>
<tr>
<td>Injury And Poisoning</td>
<td>721</td>
<td>12.6%</td>
</tr>
<tr>
<td>Mental Disorders</td>
<td>325</td>
<td>5.7%</td>
</tr>
<tr>
<td>Neoplasms</td>
<td>22</td>
<td>0.4%</td>
</tr>
<tr>
<td>Symptoms, Signs, And Ill-Defined Conditions</td>
<td>1680</td>
<td>29.3%</td>
</tr>
</tbody>
</table>


**Latent Class Analysis**

To conduct the latent class analysis (LCA) SAS software (Version 9.3: Cary, N.C.) was used. The PROC LCA procedure for SAS was utilized (University Park: The Methodology Center at Penn State, 2015). The SAS procedure produces the two estimated parameters critical to LCA—the class membership probabilities and the item-response probabilities conditional upon group membership, as well as relevant model fit statistics. This software has been used in a many other published studies where latent class analysis was performed (Evans-Polce, Lanza, & Maggs, 2016; Schuler, Puttaiah, Mojtabai, & Crum, 2015; Vasilenko, Kugler, Butera, & Lanza, 2015).

**Model-building**

Per LCA modeling guidance from Lanza et al. (2007), first, variables were selected for the model prior to the imposing the number of classes on the model. In the initial model-building phase of the analysis, simple two-class models were fit. One of the first major observations was that categorical variables with higher numbers of levels were very difficult to interpret. To simplify the interpretations, some variables (namely the discharge diagnosis variable) were eventually re-coded to binary variables, rather than maintaining the original variable structure with 17 levels. A video produced by the Methodology Center at Pennsylvania State University confirmed that researchers using latent class analysis often find binary variables easier to work with, and tend to have more commonly understood interpretations (The Methodology Center at Penn State, 2012). Thus, there was a preference for lower numbers of levels in the variables input into the latent class model.

First, the non-clinical categorical variables were fit into the latent class model using variables believed to meaningfully distinguish emergency department frequent users from one another. It was found that four variables seemed to best separate the population of ED frequent users into two classes. These variables were: (1) the percent of ED visits that resulted in an inpatient or observation admission, (2) chronic ED use (defined as being ED frequent user for 2 years in a row), (3) high frequency ED user
(using the ED 10 or more times in 2014), and (4) the number of all cause 30-day readmissions. Model fit statistics are presented below in Table 11 for this model (Model 1). The AIC is minimized in this model, relative to all others; however, no clinical information was factored into the model. This was impractical because, in practice, if the results of the latent class analysis are to be used to develop an intervention supported by the hospital, the hospital will need to know what types of clinical resources (specialists, medical equipment, etc.) is needed to best serve the patient. For this reason, the discharging diagnosis variables were incorporated in the analysis. Additionally, it was theoretically believed that discharge diagnosis codes would likely drive separations between the latent classes.

Table 11: Latent Class Model Fit Statistics

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log likelihood</td>
<td>-17315.5</td>
<td>-18349.1</td>
<td>-7447.4</td>
<td>-16563.2</td>
<td>-11473.9</td>
</tr>
<tr>
<td>G-squared</td>
<td>138.1</td>
<td>9770.9</td>
<td>527.6</td>
<td>434.2</td>
<td>296.1</td>
</tr>
<tr>
<td>df</td>
<td>108.0</td>
<td>131036.0</td>
<td>50.0</td>
<td>476.2</td>
<td>50.0</td>
</tr>
<tr>
<td>AIC</td>
<td>176.1</td>
<td>9840.9</td>
<td>553.6</td>
<td>490.0</td>
<td>322.1</td>
</tr>
<tr>
<td>BIC</td>
<td>302.5</td>
<td>10073.8</td>
<td>640.1</td>
<td>615.9</td>
<td>408.6</td>
</tr>
<tr>
<td>CAIC</td>
<td>321.5</td>
<td>10108.8</td>
<td>653.1</td>
<td>636.9</td>
<td>421.6</td>
</tr>
<tr>
<td>Adj BIC</td>
<td>242.1</td>
<td>9962.6</td>
<td>598.8</td>
<td>549.2</td>
<td>367.3</td>
</tr>
<tr>
<td>Entropy</td>
<td>0.9</td>
<td>1.0</td>
<td>0.3</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Model 2 is a model that includes all of the 17 binary discharge diagnosis categories. As previously discussed, these categories are defined by the International Classification of Disease (ICD) panel of experts. This model performed very poorly in terms of model fit statistics relative to Model 1, but was useful to begin to build models that included the discharge diagnosis categories.

Next, models with fewer discharge diagnosis categories were fit. It was noted that some diagnostic categories, such as “Diseases of the Blood and Blood-Forming Organs” had very low prevalence in the population (only 0.5%). Using variables with very low prevalence (essentially providing little information) to describe latent class structures seemed like an inefficient way to model the underlying latent structure. A model, not presented here, was fit that included all discharge diagnosis...
categories where the prevalence of the condition was greater than 4% in the sample population. This model performed better than Model 2, but still had poor information criterion fit statistics. Model 3 represents a model that includes only specific categories of discharge diagnoses: (1) Respiratory, (2) Mental health, (3) Musculoskeletal, (4) Circulatory system, (5) Genitourinary, and (6) Digestive. These categories were selected for two reasons. First, these categories were selected because they had greater prevalence in the population. Second, it was believed that these categories could provide clinical insight into the types of patients in the latent classes. Some categories do not provide such insight—such as “Symptoms, signs, and ill-defined conditions” and the catchall category for situations where the patient never presented to the ED for the same reason twice (the “all different reasons” category). Injury and poisoning was not included in the model because most injuries and poisonings are typically unintentional, thus this category would not be expected to provide information on systematic differences between the latent classes. The categories “Injury and Poisoning” and “All different reasons” were included in some initial models to test if they would be effective explanatory items, prior to being ruled out. When they were included the models did not pass the initial model selection criteria of having a $G^2$ less than the degrees of freedom—indicating very poor absolute model fit (The Methodology Center at Penn State, 2012, 2013). From a practical standpoint, the inclusion of “Symptoms, signs, and ill-defined conditions” does not provide the clinician with any information as to what the underlying reason was for patient presentation to the ED for—as this category includes everything from chest pain to syncope (fainting) to coughing. Including this as an item in the latent class would not help clinicians tailor an intervention to the needs of a latent class.

**Model Selection**

Model 3 performed worse than Model 1 with higher model fit statistics (specifically the information criterions) and lower entropy, but had better model information criterion statistics than Model 2. The lower entropy score indicates that there is a lower level of certainty in the classification of
subjects (Templin, 2007). Model 3 combined the non-clinical items from Model 1 with the clinical indicators from Model 2 to attempt to create a model that was both useful from a practical standpoint, but also good from a model fit perspective. However, this model had poor model fit statistics (higher information criterions), but had increased entropy. In Model 3, several of the variables no longer demonstrated good latent class separation (the item-response probabilities did not differ appreciably between the two classes). Theoretically a very good model will have extreme latent class separation—however in practice, mild or moderate latent class separation is more common (Collins & Lanza, 2010). Three items had poor latent class separation: diseases of the (1) genitourinary system and (2) digestive system, and the (3) chronic disease category. These items were dropped in Model 4.

Model 4 has better model fit statistics than Model 2 and 3 but some model fit statistics are still inferior to Model 1. Model 4 theoretically improves upon Model 1 in that it provides some clinical information that can be practically used to help assign proper resources to patients who fall into the latent class categories. Reduced latent class separation between two items was observed in Model 4 (high frequency ED user (10+ ED visits/ year) and 30-day readmission). Model 5 was created- which was the same as Model 4, except it excludes the two items identified as poor latent class separators. Model 5 had superior model fit statistics over Model 4, while still maintaining good theoretical explanatory power.

All of the models in the initial model-building phase (displayed in Table 9) were two-class models. Once Model 5 was determined to be the best model, from both a statistical and theoretical/practical standpoint, additional classes of models were fit to see if there were more than two latent classes within the population of ED frequent users. The summary statistics are presented below in Table 12. This order of analysis is recommended by Lanza et al. (2007).
Table 12: Multi-class Model Fit Statistics

<table>
<thead>
<tr>
<th></th>
<th>2-class</th>
<th>3-class</th>
<th>4-class</th>
<th>5-class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log likelihood</td>
<td>-11473.9</td>
<td>-11415.6</td>
<td>-11371.8</td>
<td>-11349.5</td>
</tr>
<tr>
<td>G-squared</td>
<td>296.1</td>
<td>179.5</td>
<td>92.0</td>
<td>47.6</td>
</tr>
<tr>
<td>df</td>
<td>50</td>
<td>43</td>
<td>36</td>
<td>29</td>
</tr>
<tr>
<td>AIC</td>
<td>322.1</td>
<td>219.5</td>
<td>146.0</td>
<td>115.6</td>
</tr>
<tr>
<td>BIC</td>
<td>408.6</td>
<td>352.5</td>
<td>325.6</td>
<td>341.8</td>
</tr>
<tr>
<td>Consistent AIC</td>
<td>421.6</td>
<td>372.5</td>
<td>352.6</td>
<td>375.8</td>
</tr>
<tr>
<td>Adjusted BIC</td>
<td>367.3</td>
<td>289.0</td>
<td>239.8</td>
<td>233.8</td>
</tr>
<tr>
<td>Entropy</td>
<td>0.76</td>
<td>0.73</td>
<td>0.85</td>
<td>0.65</td>
</tr>
</tbody>
</table>

The AIC decreased as the number of classes increased. The BIC, however, decreased from the 2- to 3- to 4-class models, and then increased in the 5-class model. The Adjusted BIC, which penalizes additional model parameters and low sample size (Nylund, Asparouhov, & Muthen, 2007) follows a similar pattern—although the absolute value decreases with each additional class—with the marginal decrease from the 4- to 5-class model being very small. Entropy is highest in the 4-class model. As previously stated entropy closer to one indicates superior latent class classification and better model fit (Hruska et al. 2014).

The 4-class model was selected as the best model because it meets the absolute fit criteria ($G^2 < \text{df}$), and optimizes the relative model fit criteria by minimizing BIC and effectively minimizing Adjusted BIC (the difference between the 4- and 5-class model is negligible). Additionally, entropy is maximized. The BIC and adjusted BIC tend to perform better with respect to selecting the number of classes in a latent class model, however, Nylund et al. (2007) states that the BIC is superior to adjusted BIC for this task. Thus, the 4-class model was selected as the best model, given the data in this sample.

**Evaluation of Gender as a Grouping Variable**

Once the model inputs and number of classes were selected, patient gender was tested as a grouping variable in the final 4-class model. Grouping variables are used to determine if measurement invariance holds across the latent classes. In the event that measurement invariance does not hold, it
means that the estimated parameters vary between at least some groups and that there is not necessarily an equivalent meaning of the latent class across all groups. Gender was evaluated as a grouping variable because it has been shown that men and women use the ED at different rates (Anson, Carmel, & Levin, 1991), and there are documented gender inequalities in emergency medicine care (Fassler, 2015, Oct 15; Pope, Aufderheide, et al., 2000). Furthermore, gender is a commonly used grouping variable in latent class analyses (Lanza et al., 2007). In fitting the model with gender as a grouping variable, it was determined that the model was invariant with respect to gender, indicating gender did not need to be included as a grouping variable in the model. PROC LCA software does not calculate this test automatically in the software, and such, requires manual calculation. The calculation was completed as described by Lanza et al. (2007): Two models were estimated- one with gender invariance (freely estimated model) and one with gender grouping variable included in the model (constrained model). The freely estimated model had a $G^2$ statistic of 103.43 (df=73) and the constrained model had a $G^2$ statistic of 132.36 (df=97). The resulting difference in $G^2$ statistics was 28.93. $G^2$ statistics are roughly distributed as chi-square, and the appropriate critical value for a 5% type I error rate was determined to be 36.42. The calculated value (28.93) did not exceed the critical value of 36.42, thus the null hypothesis of gender invariance held. This means that the estimated parameters are approximately the same for men and women, and gender was not included as a grouping variable in further analyses.

**Evaluation of Covariates**

Lastly, the final 4-class model was fitted with and without covariates. The purpose of adding covariates is to examine the relationship between covariates and the latent classes, and determine which characteristics predict membership in the latent classes (Lanza et al., 2007). The addition of covariates can also help to explain differences between the latent classes to help in naming the subgroups. Age, socioeconomic status (SES, as measured by the median income in zip code being above 200% of the federal poverty level), and very high ED utilization (defined by having 10+ ED visits in 2014)
were tested as covariates. These variables were thought to theoretically be associated with different types of ED frequent users, which is why they were included as covariates in the analysis.

Only SES was found to be a statistically significant covariate. The odds ratio estimates are presented below in Table 13. The odds ratios are interpreted as the increase in the odds of membership in the latent class compared to Class 1, given that the ED frequent user has an income below 200% of the federal poverty line (FPL). Thus, there is a 43% decrease in the odds of membership (95% CI 40-83%) in Class 2 compared to Class 1 for ED frequent users with an income below 200% of the FPL. Similarly, there is a 47% decrease in the odds of membership in Class 3 compared to Class 1 when the ED frequent user has income below 200% of the FPL. The odds of membership in Class 4 does not significantly differ from Class 1 when the SES variable is modeled as a covariate in the latent class model.

**Table 13: Odds ratio estimates for the Covariate Socioeconomic Status**

<table>
<thead>
<tr>
<th>Income below 200% FPL:</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ref</td>
<td>0.57</td>
<td>0.53</td>
<td>0.82</td>
<td>0.54-1.24</td>
</tr>
<tr>
<td></td>
<td>(0.40-0.83)</td>
<td>(0.41-0.67)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Final Model**

Table 14 presents the final model adjusted for SES. Class 1 is comprised of primarily ED frequent users who have a very high incidence of having less than 50% of ED visits result in an inpatient admission (or lower admission frequency). Additionally this group rarely sustained ED frequent user status beyond 2014- with only 4% of ED frequent users being frequent users in both 2014 and 2015. A variety of primary diagnoses were observed—and none of the diagnosis categories stood out as particularly prevalent—although musculoskeletal and circulatory complaints were very uncommon.
Table 14: Final Model, Adjusted Latent Class Analysis Class Membership & Item-Response Probabilities

<table>
<thead>
<tr>
<th>Class # Membership Probability (Standard Error)</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40.31%</td>
<td>4.16%</td>
<td>35.46%</td>
<td>20.07%</td>
</tr>
<tr>
<td>Respiratory Diagnosis</td>
<td>9.61%</td>
<td>0.01%</td>
<td>10.57%</td>
<td>0.01%</td>
</tr>
<tr>
<td>Mental health Diagnosis</td>
<td>4.07%</td>
<td>0.01%</td>
<td>10.65%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Musculoskeletal Diagnosis</td>
<td>0.01%</td>
<td>0.01%</td>
<td>1.12%</td>
<td>33.05%</td>
</tr>
<tr>
<td>Circulatory Diagnosis</td>
<td>0.67%</td>
<td>97.83%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Inpatient Admission (admitted &lt;50% of the time)</td>
<td>93.56%</td>
<td>20.36%</td>
<td>52.17%</td>
<td>95.62%</td>
</tr>
<tr>
<td>Chronic ED Frequent User</td>
<td>4.26%</td>
<td>50.33%</td>
<td>61.75%</td>
<td>20.49%</td>
</tr>
</tbody>
</table>

Class 3, on the other hand, had a higher admission frequency but presented a similar distribution of mixed findings with respect to primary diagnosis responsible for the majority of ED visits. The major difference between Class 3 and Class 1 is the percent of chronic ED frequent users. If an individual is a member of Class 3, there is a 61.75% chance they will be an ED frequent user in both 2014 and 2015 (compared to 4.26% in Class 1). Class 1 and 3 make up approximately 75% of the total sample population. Class 1 is slightly larger than Class 3 (40.31% vs 35.46%).

Class 2 differs from all other classes in that it is a much smaller class—4.16% of the population of ED frequent users. The distinguishing items of Class 2 are that the item-response probability for circulatory conditions is 98% of this group. Thus, if an individual is a member of Class 2, there is a 98% chance that the majority of their ED visits will be for a circulatory condition. This is a very distinguishing feature of this group. Membership in this group is associated with a 20.36% chance that less than 50% of ED visits will result in an inpatient stay—indicating higher inpatient utilization amongst this group.
Class 4 makes up approximately one-fifth of the population, and its members have the highest probability of presenting for musculoskeletal complaints (item-response probability of 33.05%). The item response probabilities for all other diagnostic groups are approximately 0%. Members of this subgroup have a very high probability of having less than 50% of ED visits transition into inpatient visits, indicating lower inpatient utilization, similar to Group 1.

**Differences between Subgroups**

Once the latent classes were created, and grouping and covariate variables were evaluated, individuals in the dataset were assigned to a latent class based on the highest probability of class membership, as calculated by PROC LCA. This is automatically done by the PROC LCA program. These assignments were exported into a dataset containing explanatory variables (from Table 1) to examine descriptive statistics for the latent classes. Data is presented below in Table 15.
## Table 15: Descriptive Statistics of Latent Classes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age</td>
<td>43</td>
<td>70</td>
<td>52</td>
<td>47</td>
</tr>
<tr>
<td>% Female</td>
<td>56.8%</td>
<td>58.6%</td>
<td>67.3%</td>
<td>56.0%</td>
</tr>
<tr>
<td>% White</td>
<td>62.8%</td>
<td>61.9%</td>
<td>58.3%</td>
<td>66.1%</td>
</tr>
<tr>
<td>% Medicaid</td>
<td>40.7%</td>
<td>46.2%</td>
<td>50.2%</td>
<td>39.4%</td>
</tr>
<tr>
<td>% Medicare</td>
<td>30.7%</td>
<td>32.5%</td>
<td>27.0%</td>
<td>29.3%</td>
</tr>
<tr>
<td>% Medicare and less than age 65</td>
<td>9.7%</td>
<td>12.9%</td>
<td>14.8%</td>
<td>9.3%</td>
</tr>
<tr>
<td>Median count of chronic diseases (coded on bill at last ED visit in 2014)</td>
<td>0 (IQR 0-1)</td>
<td>1 (IQR 0-2)</td>
<td>0 (IQR 0-2)</td>
<td>0 (IQR 0-2)</td>
</tr>
<tr>
<td>Median number of ED visits</td>
<td>5 (IQR 4-7)</td>
<td>5 (IQR 4-6)</td>
<td>5 IQR (4-7)</td>
<td>5 (IQR 4-7)</td>
</tr>
<tr>
<td>Median number of inpatient visits</td>
<td>0 (IQR 0-1)</td>
<td>3 (IQR 2-4)</td>
<td>1 (IQR 0-3)</td>
<td>0 (IQR 0-1)</td>
</tr>
<tr>
<td>Median number of observation visits</td>
<td>0 (IQR 0-0)</td>
<td>0 (IQR 0-1)</td>
<td>0 (IQR 0-1)</td>
<td>0 (IQR 0-0)</td>
</tr>
<tr>
<td>Average percent of ED visits that result in inpatient admission</td>
<td>14%</td>
<td>66%</td>
<td>41%</td>
<td>9%</td>
</tr>
<tr>
<td>Chronic ED frequent user in both 2014 and 2015</td>
<td>0%</td>
<td>47%</td>
<td>89%</td>
<td>19%</td>
</tr>
</tbody>
</table>

### Majority of ED visits in 2014 were for:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>All different reasons</td>
<td>11.9%</td>
<td>0%</td>
<td>11.8%</td>
<td>0%</td>
</tr>
<tr>
<td>Complications of pregnancy, childbirth, and the puerperium</td>
<td>4.4%</td>
<td>0%</td>
<td>2.2%</td>
<td>0%</td>
</tr>
<tr>
<td>Diseases of the Blood and Blood-Forming organs</td>
<td>0.4%</td>
<td>0%</td>
<td>1.1%</td>
<td>0%</td>
</tr>
<tr>
<td>Diseases of the Digestive System</td>
<td>6.0%</td>
<td>0%</td>
<td>5.8%</td>
<td>0%</td>
</tr>
<tr>
<td>Diseases of the Genitourinary System</td>
<td>5.4%</td>
<td>0%</td>
<td>4.4%</td>
<td>0%</td>
</tr>
<tr>
<td>Diseases of the Nervous System and Sense Organs</td>
<td>2.6%</td>
<td>0%</td>
<td>2.2%</td>
<td>0%</td>
</tr>
<tr>
<td>Diseases of the Respiratory System</td>
<td>8.3%</td>
<td>0%</td>
<td>9.1%</td>
<td>0%</td>
</tr>
<tr>
<td>Diseases of the Skin and Subcutaneous Tissue</td>
<td>2.8%</td>
<td>0%</td>
<td>3.3%</td>
<td>0%</td>
</tr>
<tr>
<td>Endocrine, Nutritional and Metabolic Diseases and Immunity</td>
<td>1.5%</td>
<td>0%</td>
<td>3.0%</td>
<td>0%</td>
</tr>
<tr>
<td>Factors influencing health status (v-codes)</td>
<td>1.0%</td>
<td>0%</td>
<td>0.8%</td>
<td>0%</td>
</tr>
<tr>
<td>Infectious and Parasitic Diseases</td>
<td>1.3%</td>
<td>0%</td>
<td>2.5%</td>
<td>0%</td>
</tr>
<tr>
<td>Injury and Poisoning</td>
<td>14.6%</td>
<td>0%</td>
<td>13.2%</td>
<td>0%</td>
</tr>
<tr>
<td>Mental Disorders</td>
<td>4.3%</td>
<td>0%</td>
<td>10.3%</td>
<td>0%</td>
</tr>
<tr>
<td>Neoplasms</td>
<td>0.2%</td>
<td>0%</td>
<td>0.9%</td>
<td>0%</td>
</tr>
<tr>
<td>Symptoms, Signs, and Ill-defined conditions</td>
<td>35.2%</td>
<td>0%</td>
<td>28.4%</td>
<td>0%</td>
</tr>
<tr>
<td>Diseases of the circulatory system</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Diseases of the Musculoskeletal System and Connective Tissue</td>
<td>0%</td>
<td>0%</td>
<td>1.0%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Class 2 is the oldest class, with an average age of 70, and the highest prevalence of Medicare insurance. This group also encompasses all people in the sample who made a majority of their 2014 ED visits for diseases of the circulatory system. This is similar to the latent class findings where circulatory diagnoses were a distinguishing factor, as well as the higher likelihood of inpatient admission.

Class 4 is similarly very distinct in that 100% of members made the majority of their ED visits for musculoskeletal-related diagnoses. These diagnoses are primarily for minor sprains and strains of muscles and joints. This group of patients was very rarely admitted (9% of ED visits resulted in an inpatient admission, on average)—further suggesting lower acuity.

Class 1 and Class 3 are similar in that there were a variety of reasons for clinical presentation to the ED (as shown in Table 14). What distinguishes these groups is not the clinical indicator, but rather the chronic ED use over two years. Zero percent of people assigned to Class 1 were frequent ED users in both 2014 and 2015. In Class 3, 89% of assigned class members were ED frequent users in both 2014 and 2015. Class 3 members were also admitted more frequently than Class 1 members (Table 15: 14% vs. 41%). In terms of demographics, Class 3 has the highest prevalence of females, Medicaid beneficiaries, and those who are insured by Medicare, but are less than 65 years of age (which can indicate a special medical condition like End Stage Renal Disease, or disability).

**Naming the Latent Classes**

Naming the latent classes is a standard part of the latent class analysis process. The names of the classes, or subgroups, typically highlight unique features of the subgroups. While there may be multiple unique features of a subgroup, one name is selected that best describes the most unique features of the subgroup. In this case, unique features were very apparent for some groups, and less apparent for others.

The simplest case is Group 2, named the Heart subgroup. The group is given this name because, based on the item-response probabilities (Table 14), there is a 98% chance that, if a person is a member
of this group, the majority of their ED visits will be for a heart-related (circulatory) diagnosis. This is further confirmed in Table 15 because 100% of the ED visits made by individuals assigned to this subgroup of ED frequent users are for heart-related diagnoses. This means that the primary diagnosis code for these patients fell into the “Diseases of the Circulatory System” ICD-9 coding chapter. This includes diseases such as: hypertension, ischemic heart disease (including acute myocardial infarction, or heart attack), heart disease, stroke, and endocarditis.

As previously stated, groups 1 and 3 were similar on the clinical indicators that were input into the latent class model (Table 14). In Table 15, compared to group 1, group 3 is older, more likely to be female, non-white, and insured by Medicaid or dual-eligible. Additionally, group 3 had a higher average percent of ED visits that resulted in an inpatient hospitalization than group 1—indicating greater inpatient utilization. Lastly, 89% of individuals assigned to group 3 were chronic ED users, while 0% where chronic ED frequent users in group 1. For this reason group 3 was named “long-term” because these ED frequent users are longer-term frequent users more often than any other group member. The item-response probabilities from Table 14 indicate that there is a 61.75% chance that, if an individual is assigned to this group, they would be a chronic ED frequent user.

The name given to group 1 contrasts directly with the name for group 3 (the long-term group). Group 1 was named “short-term” because their frequent ED use appears to be temporary, or less than one year. The short-term ED frequent users tend to have similar clinical characteristics as the long-term group—but, compared to group 3, they are younger on average, less frequently female (although still predominantly female), less likely to be insured by Medicaid, and more likely to be insured by Medicare. Another distinguishing feature that separates is the lower percentage of ED visits converting to inpatient hospital stays (14% in the short-term group compared to 41% in the long-term group). While this was a distinguishing feature, it is not captured in the group name. Guidance from Lanza et al. (2007) suggests keeping group names very simple to avoid confusion.
Lastly, group 4 was named “minor care”. The first distinguishing factor about this group is that they have lower levels of inpatient hospitalization. The item-response probabilities in Table 12 show that a member of this group has a 95.62% chance of having less than half of his or her ED visits transition to an inpatient hospital stay. The descriptive statistics from Table 6 further demonstrate this. The median number of inpatient stays was 0, and even at the 75th percentile, the number of inpatient stays was 1. Another novel feature was that, if a person was assigned to this group, there was a 33% chance the primary reason for their ED visit was related to a musculoskeletal complaint (Table 14). In Table 13, it shows that 100% of the primary reasons for ED visits among people assigned to this group were for musculoskeletal complaints. It could be argued that this group should be called “musculoskeletal” rather than “minor care”, but because the latent class item-response probabilities only assigned a 33% probability of having musculoskeletal as the primary discharge diagnosis code for the majority of ED visits- the more general term “minor care” was used. The term minor care encompasses many of the sprains and strains in the musculoskeletal ICD-9 chapter, as well as the concept of these patients have very low rates of inpatient hospital admissions. Furthermore, when this data was presented to the emergency medicine physicians familiar with this project, they agreed that “minor care” was a better categorization of the characteristics of this group than “musculoskeletal”.

Table 16 below presents the named subgroups and the unique features that contributed to their naming. The naming conventions were created by examining the item-response probabilities and associated demographics. A group of emergency medicine physicians also provided their insight and thoughts on the naming conventions, based on their interpretations of the data.
Table 16: Latent Class Subgroup Names and their Defining Attributes

<table>
<thead>
<tr>
<th>Short-term frequent ED users</th>
<th>Heart-related frequent ED users</th>
<th>Long-term frequent ED users</th>
<th>Minor care frequent ED users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have very low rates of chronic (multi-year) frequent ED use</td>
<td>Vast majority of patients make ED visits for heart-related diagnoses</td>
<td>Vast majority of assigned group members have used the ED with frequency for 2 years in a row</td>
<td>Very low rates of admission among members assigned to this group</td>
</tr>
<tr>
<td>Low probability of having majority of ED visits translate to inpatient admissions</td>
<td></td>
<td></td>
<td>Present mostly for sprains and strains</td>
</tr>
</tbody>
</table>

Cost-Analysis

The final part of this analysis is an analysis of hospital costs. Full costs in this sense are defined as full costs to the hospital, representing both fixed and variable costs (for example, inclusive of categories like labor, equipment, supplies, etc.). Full costs came from a hospital accounting dataset, and were matched to patients using a patient visit identifier. When the patient visits were matched between the analytic dataset identifying the 5,731 ED frequent users and the accounting dataset, 5451 out of 5731 (95%) matched. Given the importance of the billing function, a high rate of matching is expected. Not all records are expected to match; however, since a bill is not always generated in the event that it is known that a patient will not pay a bill (as is the case in charity care). Additionally, it is possible that clerical errors accounted for some of the non-matches, although the incidence of this cannot be known.

Table 17 below displays the results of the cost analysis. The long-term ED frequent users are the most costly group, in terms of total full costs (approx. $4.5 mil). This is not surprising, given the high rate of inpatient admission among this group. The second highest total cost group is the short-term ED frequent user group. It should be noted, however, that this group’s per visit cost is much lower than the long-term group’s average visit cost ($1,196 vs. $2,807). Similarly, this is not surprising to observe lower average per visit costs among this group given the lower rate of inpatient admission.
Table 17: Cost analysis of ED Frequent User Subgroups

<table>
<thead>
<tr>
<th></th>
<th>Short-term frequent ED users</th>
<th>Heart-related frequent ED users</th>
<th>Long-term frequent ED users</th>
<th>Minor care frequent ED users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count of patients</td>
<td>3,383</td>
<td>249</td>
<td>1,713</td>
<td>386</td>
</tr>
<tr>
<td>Sum of full costs</td>
<td>$3,879,519</td>
<td>$1,273,288</td>
<td>$4,501,810</td>
<td>$344,903</td>
</tr>
<tr>
<td>Average full costs</td>
<td>$1,196</td>
<td>$5,609</td>
<td>$2,807</td>
<td>$922</td>
</tr>
</tbody>
</table>

Heart-related ED frequent users accrued the highest average per visit costs at $5,609. This is a small group of individuals (249 patients) who are frequently admitted for heart-related care. Admission to a unit requiring telemetry is known to be associated with higher costs than other hospital units given the increase in required technology and training for staff required to operate telemetry units (Benjamin, Klugman, Luckmann, Fairchild, & Abookire, 2013). Furthermore, given that the average age of patients in this group was 70, it may be the case that some of these patients were visiting the hospital at the end of life. End of life expenditures are known to be very high in the United States (Scitovsky, 2005).

Lastly, as expected, the minor care group exhibited the lowest cost per visit as well as the lowest total cost. This group was relatively small compared to other groups (386 people), but not as small as the heart group (249 people). Given the very low levels of inpatient utilization among this group, and the relatively small number of people in the group- a low level of full costs is to be expected.

An analysis of fixed vs. variable costs was also performed to understand if the distribution of fixed vs. variable costs varied with respect to subgroups. Overall, 32% of costs were variable and 68% of costs were fixed. Table 18 below demonstrates a relatively even distribution of fixed and variable costs across subgroups. Across all subgroups variables costs fluctuated between 31-33% of total costs and fixed costs ranged from 67-69% of total costs. The distribution of variable and fixed costs could potentially influence the decision of which group to provide with an intervention since fixed costs cannot be easily changed in the short-run.
Table 18: Fixed vs. Variable Costs by ED Frequent User Subgroups

<table>
<thead>
<tr>
<th></th>
<th>Short-term frequent ED users</th>
<th>Heart-related frequent ED users</th>
<th>Long-term frequent ED users</th>
<th>Minor care frequent ED users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of variable costs</td>
<td>$1,206,715</td>
<td>$423,903</td>
<td>$1,444,163</td>
<td>$113,480</td>
</tr>
<tr>
<td>Variable costs as</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>percent of total costs</td>
<td>31%</td>
<td>33%</td>
<td>32%</td>
<td>33%</td>
</tr>
<tr>
<td>Sum of fixed costs</td>
<td>$2,672,803</td>
<td>$849,385</td>
<td>$3,057,647</td>
<td>$231,424</td>
</tr>
<tr>
<td>Fixed costs as</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>percent of total costs</td>
<td>69%</td>
<td>67%</td>
<td>68%</td>
<td>67%</td>
</tr>
<tr>
<td>Sum of total costs</td>
<td>$3,879,519</td>
<td>$1,273,288</td>
<td>$4,501,810</td>
<td>$344,903</td>
</tr>
</tbody>
</table>

The last research question asked which group should be recommended for intervention, based on the greatest cost-avoidance opportunity. In this case, there is a dual recommendation to intervene with the long-term group and heart-related groups.

While the long-term group is not the most costly group on a per-person basis, it is the most costly group with respect to all cost categories. Furthermore, on average, group members in the long-term group are younger than the heart group, which may suggest that additional benefits could be gained over time, as it is expected that the long-term group has more years of life remaining. Furthermore, given that mortality was not assessed as part of this analysis, it is not known how many of the heart patients were discharged as expired, or discharged to hospice care where the impact of any utilization intervention may not be appropriate. The long-term group has many members who have more than one-year of frequent ED use, suggesting a reliance on the health system that may be able to be relieved through concentrated care management, or other strategies. The group is also very large, which 1,713 individuals in 2014. From a practical standpoint, working with a larger group may be more beneficial as some individuals may refuse to participate, or may have expired, or moved out of the area. Working with a very small group limits the number of participants eligible to participate in the first place, but with a group as large as the long-term group, there is a much larger supply of patients for care managers or other works to work with.
The heart-related group is the most costly on a per-person basis at $5,609 per patient (total costs). This is a much smaller group with only 243 people, but with such high per-person costs, even small reductions in utilization could result in substantial savings. Given the high frequency with which this group presents to the ED and inpatient units, evidence of cost-avoidance may be realized more quickly than with the long-term group that may take several months or even years to realize substantial benefits, depending on the intensity and effectiveness of the selected intervention.
Chapter 5: Discussion

Given the unsustainable growth in health care costs, cost-containment strategies across the entire health industry are constantly being evaluated. Emergency department care is among the most expensive care an individual can receive, accounting for 2% of all healthcare expenditures (Lee et al., 2013), thus emergency department utilization often receives a great deal of scrutiny. Easy access to imaging technology, laboratory services, and physician consults, in addition to access to inpatient units makes it easy for health care charges to accumulate. Furthermore, as expert diagnosticians, emergency medicine physicians are subject to substantial pressure to rule out any life-threatening conditions—even if the probability of such disease is very small. The ever present threat of malpractice in the United States forces defensive medicine practices across all medical specialties, including emergency medicine (Tuers, 2013). Defensive medicine is a practice where healthcare providers overuse tests and procedures to rule out all possible causes of illness, despite the inefficiencies this causes, for fear of being sued at a later date. This increases the intensity, and associated costs, of services delivered in all areas of the healthcare delivery, including the ED. Estimated costs for defensive medicine practices were $45 billion in 2008 (Mello et al., 2010). It has been estimated that 28% of orders and 13% of costs are delivered in part out of concerns of litigation, and approximately 3% of costs are completely for defensive purposes (Rothberg et al., 2014).

Given the high costs associated with healthcare in the U.S. and the costly nature of the emergency department, health policy-makers and administrators have looked to the ED to contain costs. One tactic to reduce health care expenditures has been the targeting of ED frequent users with utilization management interventions. Given the frequency with which this population uses the ED, defined by using the ED four or more times in a 12-month period, it is believed that there is an opportunity to improve the health and well-being of this population, which will lead to a reduction in
the reliance on the emergency department, as well as other health care services, such as costly inpatient admissions.

The majority of the literature on interventions for ED frequent users has been performed at single-sites, usually using a pre-post study design where patients serve as their own controls before being exposed to an intervention, and are then subsequently followed to observe their health care utilization behaviors. The literature has shown positive impacts on utilization (Althaus et al., 2011), although it is suspected that these utilization reductions are likely due to natural health problem resolution or other normal changes in utilization that would have happened without the intervention (Johnson et al., 2015). Randomized controlled trials for ED frequent user interventions have shown much less success with respect to utilization and cost reduction (Althaus et al., 2011) further suggesting that the pre-post cohort design studies may truly be confounded by natural reductions in utilization. This begs the question as to why the RCTs evaluating interventions for ED frequent users do not have better results. One supposition is that the universal targeting of all ED frequent users by interventions is not optimal, and potentially ineffective. An alternative methodology would include targeting interventions to smaller, distinct homogeneous sub-populations, where the intervention could be tailored to the specific needs of the group. This methodology is supported by evidence showing the increases in effectiveness achieved when interventions are targeted to specific, homogeneous populations, rather than being targeted at entire populations (Aspinall et al., 2015; Clarke et al., 1993; Clarke et al., 1995). However, without a standard typology or grouping of ED frequent users, this has not been possible.

The population of ED frequent users is a heterogeneous group (Billings & Raven, 2013; Camden Coalition of Healthcare Providers, 2015; Johnson et al., 2015). ED frequent users have varied demographics, diverse diseases—of both the physical and mental variety, social challenges in some cases, as well as a variety of beliefs about the health care system. A single intervention cannot
effectively target a population as large and diverse as ED frequent users. For this reason, it is believed that using interventions that are targeted to a specific sub-group of the ED frequent user population that can subsequently be tailored to their distinct needs may be a more effective means of improving the health and reducing utilization among this population. A survey of ED frequent users was conducted at the institution where the present analysis took place to characterize demographics and understand preferred hospital service offerings to support overall health and well-being. The survey found that when ED frequent users were asked about the services they wished the hospital would provide to help them improve their health, the answers varied widely with no single answer representing the majority of ED frequent users (Birmingham et al., 2017). This provides further evidence of not only the heterogeneity of ED frequent user characteristics, but also evidence of the heterogeneous nature of the solutions to what may decrease their ED use. The preference for a variety of solutions among ED frequent users supports the concept of targeted and tailored interventions for this population, as this approach would theoretically provide appropriate resources for ED frequent users, based on their characteristics.

Scientific literature has demonstrated that targeted and tailored interventions are more effective than generic or universal interventions (Aspinall et al., 2015; Clarke et al., 1993; Clarke et al., 1995; Fisher & Fisher, 1992; Glanz et al., 2002; Kroeze et al., 2006; Meropol et al., 2014; Noar et al., 2007). However, before a targeted intervention can be delivered, a typology of ED frequent users needs to be established. Once a population is defined, the population can be targeted, and intervention(s) can be developed and tailored to the distinct needs of the population. While no standard typology of this population exists, attempts have been made to group ED frequent users into disease-based and visit-based categories. The Camden Coalition of Healthcare Providers uses clustering as a means to group high utilizing patients into somewhat homogeneous groups (Billings & Raven, 2013; Camden Coalition of Healthcare Providers, 2015; Johnson et al., 2015). However, especially in the case of disease-specific
groupings, if the behavior driving the high ED use is not the sole cause of the disease or the number of ED visits, interventions targeted to these diseases may not be effective. Rather, looking at how multiple characteristics interact provides more insight into what may truly be driving the frequent ED use. The Camden Coalition examines two factors, ED utilization and total cost of ED and inpatient spending, which is more sophisticated than a single-factor grouping mechanism. However, this still leaves out important factors like age and disease-status which would likely be related to the type and style of intervention.

Latent class analysis (LCA) uses a multi-factorial approach to determining group membership. Many variables were considered in the creation of the model. The LCA model utilizes disease-specific variables, a measure of chronic frequent ED use, as well as a measure of inpatient utilization. This methodology improves upon previous grouping methodologies because it: (1) includes more variables to describe differences between groups and similarities within groups, (2) group membership is decided in a more objective manner using the latent class statistical methodology, rather than a priori as in other analyses, and (3) it uses a novel statistical methodology that has not been applied to this population. The use of this methodology to establish homogeneous subgroups represents the primary contribution this work makes to the ED frequent user literature. Any provider or health insurer could utilize this methodology to identify homogeneous subgroups of ED frequent users within their own unique population. While this study was conducted in a part of the country that is demographically very similar to the rest of the country, local or temporal changes could impact the allocation of individuals to latent classes, thus providing institutions with a methodology to determine their own homogeneous subgroups is a valuable contribution.

The results of this latent class analysis produced an illustrative typology of four groups of Summa Health- Akron Campus ED frequent users that shows how this methodology can produce meaningful homogeneous subgroups of ED frequent users. The LCA established the (1) short-term, (2)
heart conditions, (3) long-term, and (4) minor care subgroups. Each of the four groups is a homogeneous group that is substantively different from other groups. Given that individuals within the subgroups are similar, it is likely that similar interventions and resources would be appropriate. Similarly, given that groups are different, it is unlikely that an intervention for one group would be entirely appropriate for another group. Thus, interventions would need to be group-specific, or tailored to the unique needs of the group. By tailoring resources to homogeneous groups, it prevents resources from being delivered to individuals who do not require that level or type of service. For example, a patient in the heart group likely does not need a primary care referral since the vast majority of these patients are insured by Medicare where establishment of primary care physicians is required by many Medicare plans. Thus, large scale efforts to connect these patients with primary care physicians would not be a good use of resources. In short, each group would likely be best served by being targeted with an intervention that has been tailored to the unique needs of the homogeneous subgroup.

The short-term group is primarily made of up of relatively young individuals, compared to the other 3 groups. No members of this group were frequent ED users in both 2014 and 2015, indicating their frequent use is temporary. Additionally, this group has the lowest count of chronic diseases and has relatively low levels of inpatient utilization. This paints a picture of a young group with lower acuity visits, as evidenced by the lack of inpatient utilization and low levels of chronic disease. The analysis of covariates showed that this group had high odds of being below 200% of the federal poverty line, compared to other groups. Interventions for this group may or may not be appropriate depending on how quickly resources can be orchestrated, and improvements can be made. Given that this group tends to resolve on their own within 12-months, it may not be prudent to invest significant resources in reducing this time by only a few weeks or months. This is the youngest group, indicating it may be the first time some of these patients are dealing with significant health issues, and may be learning how to use the health care system for acute sickness. If a health system did prefer to intervene with this group,
interventions focused on providing referrals to primary care and specialists may be most appropriate, in addition to providing knowledge about urgent care services in the area, for a group that is presenting to the ED for primarily low acuity complaints.

The heart group is substantively different. This group is the oldest of the four groups, and has the highest rates of inpatient utilization. Approximately half of the group members are chronic ED frequent users, demonstrating frequent ED use in both 2014 and 2015. The most distinguishing feature of this group is the use of the ED for primarily heart-related complaints. While this is the most costly group, on a per person basis, it is a relatively small number of people, with only 249 in the population studied. Given that the group is so small, it makes delivering an intervention in a way that would have a significant impact on overall costs more difficult. However, because the costs per person are very high for this group, even small reductions in emergency care (and resulting inpatient admissions) could have a substantial impact on overall costs. Potential interventions for this group could include cardiovascular resources to manage heart and vascular conditions (if the patient does not already have this resource) as well as access to a pharmacist with complete medication lists to reconcile all medications.

Additionally, there is a strongly established relationship between poor mental health and onset of diseases of the heart and poor heart health outcomes (Niranjan, Corujo, Ziegelstein, & Nwulia, 2012; Roest, Martens, de Jonge, & Denollet, 2010). Effective interventions have shown that when underlying anxiety and depression are addressed, mortality outcomes from heart disease are reduced (Rutledge, Redwine, Linke, & Mills, 2013). As a result, incorporating mental health treatment into heart-related care would also be something health systems and providers could consider when designing interventions for ED frequent users in the heart group. Additionally, incorporating regular exercise has been shown to effectively reduce heart-related health problems (Heran et al., 2011). As such, including exercise physiology of athletic trainers with education and training related to training older individuals...
could also be an effective component of an intervention aimed at improving health and reducing health care costs.

The long-term group is most similar to the short-term group, in so much that both groups present to the ED for a variety of healthcare problems or complaints. The primary difference is that the vast majority of members of the long-term group were ED frequent users in both 2014 and 2015. This group also exhibits higher rates of Medicaid insurance, as well as Medicare insurance with an age less than 65 years of age. Often times, individuals with Medicare insurance at ages below the traditional Medicare age have significant health problems. This group also exhibits higher rates of inpatient utilization than the short-term group, and has the highest incidence of making ED visits primarily related to mental health diagnoses. This was a large group of people, with over 1700 members, of which many had substantial inpatient utilization, making for the highest total costs out of all groups. This research did not delve into why this particular subpopulation used the ED with high frequency for multiple years, but in order to create an effective intervention for this group, that question would need to be answered. A comprehensive investigation of this issue would be prudent—examining not only utilization and clinical indicators, but also indicators of socioeconomic status, health literacy, healthcare access, and other factors that can influence health status. It is likely, given the high proportion of Medicaid and Medicare beneficiaries under age 65, that this population has significant socioeconomic barriers. Having a social worker as a part of the care team for this group of ED frequent users may be a critical component of providing effective solutions for these patients.

Lastly, the minor care group, as the name suggests, makes visits for primarily minor conditions, largely sprains and strains. This group is also relatively young compared to other groups and has the smallest percent of female members (although it is still predominantly female, like all other groups). The group has the lowest levels of both Medicare and Medicaid insurance out of all groups. The minor care group has very low levels of inpatient utilization, in addition to few members who used the ED with
frequency in both 2014 and 2015. From a cost perspective, this group offered the smallest cost-avoidance potential. However, sprains and strains can typically be treated in urgent care centers (which often offer night and weekend hours), thus education on other non-emergency options may be considered for this group. Business development strategies may also be considered to help target this group, and patients with similar complaints, such as an orthopedic clinic or orthopedic emergency department where specialized resources would be available for the treatment of sprains, strains, and associated pain management. Specialty hospitals are a growing strategy for health systems, and if specialized orthopedic resources are available, educating patients on the availability of this resource could result in reduced ED utilization, and potentially improved outcomes or service experiences given the specialized nature of this care delivery strategy (Greenwald et al., 2006).

As can be distinguished from the sub-group descriptions above, the four sub-groups of ED frequent users are very different, and different interventions would likely be appropriate if one were to attempt to leverage a population health intervention aimed at improving health and reducing utilization. The long-term group may require more social work interventions to address issues related to chronic ED use over the years (for example, perhaps transportation or primary care physician access is a problem for this population), whereas this type of intervention may not be appropriate for the short-term group members who resolve their frequent use on their own. Literature has shown that effective interventions, namely complex care management interventions, do exist for high-cost, high-need patients, which may be appropriate for this population, given their increased levels of inpatient utilization, older average age, and increased rates of chronic disease burden (Hong, Siegel, & Ferris, 2014). Referrals to cardiologists or anticoagulation clinics may be appropriate for the heart care group, but very ineffective for the minor care group who may benefit more from connections to primary care physicians or urgent care locations. Assigning appropriate resources to the right groups is part of what makes this strategy more effective than historical approaches where one resource (or a variety of
resources) was assigned to all types of ED frequent users. Providing a limited service offering for a subgroup of ED frequent users decreases the number of staff members the intervention has to employ, keepings costs low, but increases effectiveness because the resources are tailored to exactly what patients need, rather than providing them with resources they do not need.

The individuals within these distinct groups are more homogeneous than the entire population of ED frequent users. In the ideal world with unlimited resources, four distinct interventions would be tailored to the unique needs of each group, based on data presented in the previous chapter. This makes providing a limited selection of resources for each subgroup appropriate because the subgroups are similar enough (within group) that most people in the subgroup will benefit from the same resources. Additionally, the interventions would likely differ significantly between subgroups, since there are substantial between-group differences. This is beneficial because it means that resources would not be repeated between groups, creating a potential duplication of services. This targeted approach means that resources will only be delivered to the people who need them, and not wasted on people who do not.

Given that there are limited resources to spend on public health interventions, the cost analysis provided insight into which group would offer the greatest cost-savings benefit to the organization. It was determined that the heart group would offer the greatest per encounter cost-savings opportunity, while the long-term group offered the greatest total cost savings opportunity. The recommendation made here is to pursue a dual-intervention strategy.

First, it is recommended to provide an intervention for the heart-group since this group is already very engaged with the health care system, and given the high rates of inpatient utilization, is already spending time in the facility. Engaging with this group could provide quick short-term gains in cost-avoidance. Eliminating just a few inpatient stays, through improved clinical management, could result in large cost-savings. Alternative operational strategies, outside of clinical management
improvements, could also be investigated for this population to address the costliness of their visits. Research has found that 35% of days spent on telemetry units (where heart patients typically stay) are not supported by generally accepted clinical indicators, and that lower levels of care would be appropriate (Benjamin et al., 2013). Moving these patients out of expensive telemetry units earlier in the hospital length of stay and into step-down units could result in cost-savings. Research by Benjamin et al. (2013) showed that a 400-bed hospital with 5000 non-indicated telemetry patient days could save approximately $250,000 per year in hospital costs by moving non-indicated patients to step-down units. This also results in operational improvements in the ED where new patients are waiting for a telemetry inpatient bed to open up. EDs often become “bed-blocked” when there are no inpatient beds available to discharge their admitted patients to, resulting in longer ED lengths of stay, and reduced capacity to see new ED patients, exacerbating ED crowding problems. Intervening with the heart group offers an opportunity to intervene with a high-utilizing, high-cost patient cohort who is very easily available to the hospital, given their high rates of both ED and inpatient utilization. Given the very high-cost per person in this group, making even small or moderate changes with just a few patients through improved clinical management can offer substantial cost-savings. Taking an operations approach may not have an impact on the health of this population, thus may not be appropriate to pursue in a singular fashion without additional clinical quality interventions, but will reduce the cost per admission for the entire group. Pursuing both improved clinical management through one or more of the potential interventions described previously, and operational improvements would be a potential strategy the health system could pursue. In either case, given the high frequency with which this group cycles through the hospital, near-term reductions in cost could be expected given an effective intervention.

The second part of the recommendation is to provide an intervention for the long-term group. This recommendation is offered because this is a larger group (1,173 people), thus many potential participants could be engaged. Given that not all patients will likely want to participate in an
intervention, casting a wider net offers more potential for opportunities to make change. Data has shown low levels of patient engagement across the health care system, thus it may also be the case that there are low levels of patient engagement within some of these sub-populations (Volpp & Mohta, 2016). The long-term group has the strongest record of using the ED overtime, indicating frequent ED use is an established behavior that could reasonably be expected to continue without any intervention. Data has shown that persistent ED frequent users tend to wane overtime, but a segment of this population tends to use the ED with high frequency over the course of multiple years (Billings & Raven, 2013). The long-term group is considerably younger, on average, than the heart group, which may lead to a greater return on investment over time than intervening with a group of individuals that may be nearing the end of their lifespan. This intervention would offer a cost-avoidance strategy that would be realized over the long-term. The cost per person for this patient group is substantially lower than the heart group, thus changes made to a few individuals will not have as large of an impact on costs. However, over the long-term, as this larger population hypothetically decreases their utilization, cost-savings would be realized. This intervention, as alluded to previously, would need to be developed based on further research into the needs of this population, but would likely need to address both clinical and socioeconomic factors.

This dual-intervention approach offers both a short-term and long-term approach to cost containment. The intervention with the heart group would likely result in faster realizations of cost-savings, but there will be a smaller number of people to intervene with. The long-term group will take longer to realize the cost-savings, given the lower costs per patient. However, the size of the group and the tendency to rely on the ED and inpatient units for extended periods of time could result in substantial cost-savings over the long run.

Both fixed and variable costs were considered in the analysis. As stated previously, 32% of costs were variable and 68% were fixed. Hospitals typically have high levels of fixed costs (Bamezai et al.,
2005; Roberts et al., 1999). Prior data have suggested that hospitals operate with 16% variable and 84% fixed costs, although such statements are completely dependent on how costs are categorized (as fixed or variable) making cross-institution comparisons imperfect (Roberts et al., 1999). In more recent times, hospitals have moved towards more flexible staffing models where staffing levels can be flexed up or down based on hospital occupancy rates (Bamezai et al., 2005). The ED where this analysis was conducted does subscribe to this practice of flexible staffing based on volumes, however, as a large ED with a Level 1 Trauma Center accreditation and numerous other accreditations, minimum staffing levels must be maintained for accreditation purposes (in addition to general patient safety and well-being). Thus, in an ED of this nature, it is possible that there are higher levels of variable costs because of minimum staffing requirements.

This level of cost analysis (fixed vs. variable costs) was considered because interventions would likely only be able to impact variable costs in the short-run, while fixed costs can theoretically only be adjusted over the long-run. This means that, in the short-run, only 32% of costs would be able to be impacted by a frequent ED user intervention. The long-term group has the highest overall costs in all categories (including variable costs), thus from a variable-cost only perspective, it would still be optimal to intervene with this group. Similarly, the heart group has the highest average variable costs of all groups, further solidifying the recommendation for an intervention for this group. A consideration of the cost-avoidance potential with respect to variable costs is prudent, since in the short-run, it is likely that only reductions in variable costs could be made. Thus, if a hospital administrator sets their sights on reducing the total costs associated the long-term ED frequent user group by half (from $4.5 million to $2.25 million); this will require reductions in fixed costs since only approximately one-third of total costs are attributable to variable costs. In the short-term, this is unlikely to occur, thus an examination of variable costs would promote realistic goal-setting on cost-reductions associated with the frequent ED subgroups. A reduction of long-term costs is possible, and if utilization is truly reduced, reducing or
repurposing fixed assets could become necessary. For example, theoretically, if a hospital successfully improved the health of a population (for example, the heart group) and substantially reduced utilization among the population over the long-run, it may consider reducing the size of the hospital space allocated for that population (for example, reduce the number of beds on the telemetry floor). In reality, this may not occur as populations fluctuate with older members passing away and newer members coming in, but substantial changes in technology (for example, drugs, devices, etc.) or innovations (for example, in-home telemetry care) can necessitate changes in fixed assets. To be clear, however, short-term goal-setting for cost reduction should focus primarily on variable costs.

The extent to which cost-savings could be expected to be reduced, given a reasonable intervention are not entirely known, since no interventions utilizing latent class groupings have ever been implemented. In fact, very few interventions evaluated with randomized controlled trials have demonstrated effectiveness (Soril et al., 2015). However, targeted and tailored literature has shown that this style of intervention is effective in meeting project objectives. One intervention aimed at changing primary care pediatrician behavior using a targeted and tailored intervention with respect to wellness screenings documented statistically significant improvements in lead screening (24.1 percentage point improvement), obesity assessment (79.3 percentage point improvement), and oral health screenings (89 percentage point improvement) (Meropol et al., 2014). This project demonstrates how effective targeted and tailored interventions can be, although, aimed to improve the behavior of physicians, rather than patients. Targeted and tailored interventions for patients have also demonstrated success. A meta-analysis of targeted and tailored health communication interventions demonstrated that tailoring an intervention has a greater impact on health behavior than traditional methods, although exact rates of improvement varied between projects and outcomes being evaluated (Noar et al., 2007). The Noar et al. (2007) analysis determined that tailored messages had a 20% increase in the odds of changing participant behavior when compared to generic or targeted-only messaging. If the odds ratio is
translated into a probability (17%), indicating we would expect 17% improvement in the health behavior, it could be a reasonable starting place to set a goal of an approximate 17% reduction in hospital and/or ED utilization among ED frequent users if given an effective targeted and tailored intervention.

At the end of the day, the health system would need to consider what resources it could make available to provide assistance to patients, and what the financial and operational goals of the intervention would be before deciding which group to intervene with. If the system had great interest and excess capacity from geriatricians, cardiology, and behavioral health, it may make sense to focus on the heart group first before trying to intervene with other subgroups where there may be more organizational barriers. Furthermore, if the health system or hospital has more expertise or momentum around process improvement than clinical quality improvement, focusing on subgroups that can be served by operational improvements may be a good starting place. Additionally, hospitals should also consider the size of their own subgroups within their specific patient population. While the heart group may be small in the sample that was studied here, it may be larger in areas that have greater numbers of older adult patients. Again, the latent class methodology allows unique organization to develop their own typologies that are reflective of the characteristics within their patient population. This improves the ability of interventions to be tailored to the truly unique elements of a population within a specific locale.

**Why do this Type of Research?**

This type of research is important to the field of public health because it provides a novel methodology to produce a typology of ED frequent users. A method that produces a typology provides the foundation on which tailored interventions targeted to specific latent classes of ED frequent users can be developed. Given that tailored and targeted interventions are known to be more effective than
universally delivered general interventions, it is possible that such interventions could improve upon prior interventions, even when evaluated via randomized controlled trials. Improved effectiveness in reducing health care consumption could subsequently lead to reductions in health care costs. Most importantly, effective interventions that reduce health care consumption are likely achieving this through improved health outcomes for patients, which should be at the heart of any population health strategy, even when financial considerations are also at stake. This is important to note, that improved patient health is the vehicle by which reduced health care costs are delivered in this paradigm.

The latent class methodology is a different approach to take to reduce health care costs via intervening with high-utilizing ED patients. A much more simple approach (and an approach that has been highly utilized) would be to identify high-utilizing patients (or high-cost patients) and provide an intervention to the population. The trouble with this is that the population of ED frequent users has been found to be homogeneous, thus, creating an effective intervention that will work for a diverse group of people is very challenging. The resulting randomized controlled trials have shown little improvement in ED frequent user healthcare utilization (Soril et al., 2015). The method of improvement proposed here is not to use latent class to identify high-cost users; rather, it is to identify homogeneous subgroups of ED frequent users that can be targeted with tailored interventions. Given that tailored interventions are more effective, it is reasonable to hypothesize that tailored interventions for homogeneous subgroups of ED frequent users may also be more effective than the current generic, non-tailored interventions (Noar et al., 2007). The hypothetical reductions in utilization would not occur because the highest utilizing subset of patients was targeted, but rather because the right interventions would be targeted to the right groups of people.

Research like this is necessary to control healthcare costs. Certainly one-time or immediate cuts to programs can reduce costs in the short-term, such as rolling back the Medicaid expansion policy. However, the impact on population health is not fully understood in programmatic reductions such as
this, and could have unintended (and costly) consequences over the long-term. Thus, creating innovations that decrease healthcare costs by improving the quality and delivery of care, such that patients become healthier is a safer, more risk-averse way to reduce healthcare costs. Strategies that do not address the root causes of high health care costs in ways that improve health can potentially backfire, potentially costing more over the long-run by creating problems with access to affordable healthcare and the quality of healthcare.

The need to quickly reduce health care costs may become reality for state Medicaid program officials if the proposed American Health Care Act (AHCA) or Better Care Reconciliation Act (BCRA) becomes law. In these proposed laws, Medicaid funds will be reduced, thus necessitating greater attention on cost containment. Decreasing hospital and ED utilization would be one way to cut Medicaid costs. Having a typology on which to base targeted and tailored interventions for ED frequent users may be a means of achieving cost reductions in this population.

Many parties in the health care industry can benefit from this research. ED frequent users themselves have much to gain from increased attention from care providers—in terms of potentially improving personal health, as well as decreasing personal expenditure on health care-related visits (especially costly ED and inpatient visits). Medical debt is major contributor to bankruptcy in the United States. Research has shown that 62.1% of all bankruptcies are related to a medical cause (Himmelstein, Thorne, Warren, & Woolhandler, 2009) thus the impact of personal medical expenditures for those who use the health care system with great frequency cannot be ignored.

Additionally, both hospitals and insurers are well-positioned to leverage targeted and tailored interventions for ED frequent users, and also have substantial benefits to gain. The proliferation of electronic medical records have given hospitals and associated payers access to more data than ever before. Hospitals are more easily positioned to intervene with ED frequent users since these patients are visiting their facilities with regularity. By reducing frequent ED user reliance on the ED they can
potentially shift these patients from the ED to more appropriate care settings (such as primary care, outpatient dialysis, outpatient psychiatry, etc.) depending on the unique needs of the patient, thus reducing ED utilization, but still preserving market share and revenue. Subsequently, if ED frequent users rely on the emergency department less for care, it will free-up emergency resources for other medical emergencies, potentially reducing problems related to the decline in EDs nationwide, and reducing concerns over ED crowding and emergency medicine shortages.

Insurers are also positioned to intervene with this population. Given their access to patient claims data, they have a wealth of information that can be used to identify patients. Additionally, as a payer, insurers have much to gain from any cost-savings that can be achieved through ED utilization reduction. Access to ED frequent users is more difficult for insurers—but for closed health care systems (for example, Kaiser Permanente) or Accountable Care Organizations or other structures where the payers work closely with providers, this challenge can more easily be overcome. Insurers and hospitals have more commonly come together to solve population health problems in recent times, and in many cases hospitals have even acquired health plans as both a diversification strategy and means to reap more of the benefits from population health endeavors (Evans, 2013). In situations where the payer-provider relationship is not as strong, telephonic care management interventions could also provide a means to connect with this population (Miller, Roane, & McLin, 2016; Morello et al., 2016).

Lastly, the general ED-using population also has much to gain from improvements in the health and utilization of ED frequent users. ED crowding issues are a concern for anyone who may need to use emergency medical services in the future. Concerns about ED crowding are increasing as the number of EDs declines, especially in lower income neighborhoods where freestanding emergency departments tend not to locate. Decreasing ED frequent user resource utilization may result in greater availability of ED resources available for those having medical emergencies.
While this research was conducted at a single-site, the demographics of Akron, Ohio are not unlike much of the rest of the nation. According to data from the 2010 census, the median age of a person living in the city of Akron is 36.6 years, whereas the overall median age of a person living in the United States is 37.6 (U.S. Census Bureau, 2010). Approximately 62% of those living in Akron are white vs. 73% in the entire United States. The United States is comprised of 29.8% of family households with children under 18 years of age, compared to Akron at 25.1% (U.S. Census Bureau, 2010). Thus, while there may be slight differences in the metrics presented here, the Akron community is fairly similar with respect to demographics to the United States as a whole. In terms of frequent ED utilizers, as the results and a prior publication describing ED frequent users have shown (Birmingham et al., 2017), the ED frequent user population at Summa was very consistent with previous literature findings describing characteristics of ED frequent users (LaCalle & Rabin, 2010). Given the similarities between ED frequent users defined at Summa, and the population similarities between Akron and the rest of the country, it is believed that the results would generalizable to other hospitals and emergency departments, although a caveat is further discussed in the limitations section with respect to latent classes potentially changing temporally. Regardless, the latent class methodology can be applied in almost any setting. The methodology allows any institution to categorize ED frequent users using institutional or population-specific data. Thus, rather than relying on the four classes established here, an institutional could easily establish their own institution-specific latent classes of ED frequent users.

**Future Research**

Much work has yet to be done with respect to both the typology of ED frequent users and subsequent interventions. This analysis was conducted at a single-hospital, thus similar analyses at other institutions or with larger datasets (for example, National Emergency Department Samples (NEDS)) will help to determine if this typology is standard across all ED frequent users, of if it is truly specific only to the institution where the analysis was conducted. Differences in populations of ED frequent users could
drive differences in sub-group characteristics and subsequent latent classes. Therefore, studies that validate or otherwise test the generalizability or representativeness of this typology are needed.

It is possible that the typology could evolve overtime as the population evolves, or new health threats become prevalent. For example, with the growing opioid crisis, addiction and the subsequent lack of effective resources available to some populations of addicts may become a more common root cause of ED frequent use, potentially creating a new subgroup of ED frequent users. Data from the ED where this was conducted have suggested that the opioid epidemic did not become substantial until after the data was collected for this analysis (Birmingham & Nielson, In-press). Thus it will be necessary to revisit the typology of ED frequent users over time to ensure the existing grouping of ED frequent users is still relevant.

Another line of work that grows out of the typology of ED frequent users is the development and evaluation of interventions for ED frequent users. The typology allows interventions to be targeted and tailored to a well-defined, homogeneous group of patients. The clinical and operational effectiveness of these interventions should be measured with respect to outcomes that are relevant to both patients and organizations providing the intervention. Ideally the interventions would be evaluated with randomized controlled trials and incorporate quality of life assessments. Additionally, cost-effectiveness research should be conducted to determine which interventions provide the most “bang for the buck” so that resources can be allocated optimally.

Lastly, creating predictive models of ED frequent users to forecast which patients will become ED frequent users could have applications. Preventative resources could be delivered to identified patients to prevent progression to ED frequent user status.

From the perspective of Summa Health where this analysis is being conducted, there is system-wide interest in projects that support the population health mission of the organization. Furthermore, projects that can improve the health of a population and improve financial performance of the
organization are even more beneficial. The latent class analysis is the first step in this process as it is the means by which homogeneous groups can be identified. Additionally, the cost analysis provides a basis on which to begin to consider where to deploy care management resources. There are limited resources available to support any goal within the organization, including population health initiatives. Thus, a recommendation on which sub-group would offer the greatest cost-savings to the organization, if delivered an effective intervention, is a helpful recommendation to the organization that is looking to improve population health and either improve or maintain its financial position. In this case, it was recommended that the health system intervene with both the heart-group and long-term groups because they offer both immediate-term and long-term cost-avoidance benefits.

**Strengths and Weaknesses**

The primary strength of this analysis is that it addresses the problem of ED frequent users from a different perspective. Randomized controlled trials of interventions for ED frequent users have not consistently demonstrated success in reducing utilization or healthcare costs. Rather than continuing to promote interventions for the entire population of ED frequent users based on the number of ED visits made, this line of thinking holds that interventions should be targeted to homogeneous subgroups (so intervention resources can be optimally allocated, or, said another way, to get the right intervention delivered to the right group) so that interventions can be more effective in achieving health improvement and utilization reduction goals. Homogeneous groups are simply more practical to target with interventions when compared to attempts to target heterogeneous, universal populations (for example, all ED frequent users). As such, intervention resources, which can sometimes be scare with respect to availability (for example, specialist physician appointments, rehabilitative services, etc.), can be more optimally allocated among ED frequent users.

Another unique element of this study is that it uses an objective statistical methodology to classify ED frequent users into homogeneous groups, latent class analysis (LCA). While LCA has
frequently been used in the field of psychology to identify patient subgroups (Evans-Polce et al., 2016; Hruska, Irish, Pacella, Sledjeski, & Delahanty, 2014; Vasilenko et al., 2015), using LCA to create intervention-ready groups of ED frequent users has not been documented in the published literature.

Additionally, a variety of data sources were used in the development of the typology including demographics, utilization rates, clinical diagnoses, and quality metric data. This differs from previous groupings of ED frequent users or other high utilizing patient populations where one or two variables are used to create subgroups of ED frequent users (Billings & Raven, 2013; Camden Coalition of Healthcare Providers, 2015; Johnson et al., 2015). This represents a more comprehensive way of grouping patients in this population, compared to prior works.

This study is not without weaknesses. A weakness of this analysis is that it is a single-site study—thus visits to other institutions were not able to be captured. The data is also reliant on individuals who stayed to receive treatment in the ED. If a patient came to the ED to receive treatment, but left before receiving treatment (commonly called a LWOT, or left without treatment), they were not represented in the dataset. Another common issue with single-site studies is the potential for lack of generalizability. While Akron, Ohio is a town that is not unlike many other American towns, this analysis may not have strong generalizability into the international community where healthcare policies that impact utilization are very different from the United States. The fact that other counties have universal insurance coverage and better access to healthcare providers could potentially impact a patient’s decision of whether or not to use the ED with frequency. Thus, universal health insurance could potentially impact the latent class categories determined by this model.

Additionally, the analysis made use of an administrative dataset, which is maintained for billing purposes, rather than for clinical delivery purposes. Thus, the presence and order of codes in the administrative dataset may not perfectly reflect that of the medical record.
Generally speaking, the ability of the latent class model to sort patients into homogeneous groups is only as good as the variables that are inputted into the model. Thus, if variables that have little to do with the reasons for why people present to the ED with high frequency were included, the model would not develop subgroups that are particularly useful for reducing ED reliance. One particular variable that would have been ideal to include in this analysis would have been a measure of acuity (such as an acuity or triage score to use as a proxy for acuity). Acuity is an issue that played into naming the groups, especially with respect to the minor care group. The term “minor care” insinuates a lower level of acuity, although acuity was not directly measured. Granted, this group had very low levels of inpatient admission, indicative of lower acuity, but a more precise measure of acuity level would have been preferred. Additionally, data from outpatient providers, such as primary care physicians would have been very useful. The availability of resources at primary care physician offices treating ED frequent users may influence a patient’s decision on whether or not to come to the ED (e.g., the primary care physician may rarely have same-day availability, or perhaps does not offer needed lab or imaging services). Furthermore, primary care physician attitudes towards managing ED frequent users could impact a patients’ desire to bypass the primary care office and come straight to the ED. Including these additional variables could potentially better inform the model. At the time of this project, these variables were not able to be captured in a systematic, reliable, or cost-effective way.

A limited number of variables were available in the available data sources, so there is a potential for omitted variables. An omitted variable in a latent class analysis means the effect captured by the omitted variable will not be present in the model, and the result is that patients could be sorted into different groups than they would otherwise be sorted into if the omitted variable had been included. Omitted variable problems are possible in almost any modeling exercise. The inclusion of a variety of variables from three separate datasets was the best strategy available to mitigate this problem given time and resource constraints. The three datasets used offered the greatest access to
systematically collect clinical, operational, and financial data on this patient population. While more detailed information could have been hand-abstracted from patient charts, it is unlikely the volume of data could have been collected in a commensurate amount of time. Furthermore, if this work is to reproduced by others to see if the latent class groupings hold in other ED frequent using populations, data extracted from administrative, quality, and accounting datasets is likely more reproducible than data that is hand-abstracted from medical charts.

An additional limitation of this project could be in how each of the variables were defined. Given that this population makes many ED visits, it is difficult to quantify the purpose for all the ED visits. In this analysis, it was determined to that the purpose of the ED visits for the individual would be represented by the most frequently observed primary discharging diagnosis code. Discharging diagnosis codes are not always representative of why the patient initially presented to the ED, and, given that the data came from a billing dataset, means that they could be influenced by the billing process and associated incentives. While this may be an imperfect way to represent the main reason for why the patient visited the ED, it was the best way to proxy this, given data and resource limitations.

Conclusion

This analysis provides a needed typology of ED frequent users based on an objective statistical methodology. The resulting four-group typology—long-term, short-term, heart, and minor care ED frequent users—provides a framework that public health practitioners can work with to develop targeted and tailored interventions. Interventions will vary between the subgroups, but they can include both clinical and operational interventions to improve care delivery, health outcomes, and subsequent utilization. It is possible that delivering targeted, tailored interventions to ED frequent users may be more effective than the standard universal interventions delivered to this population, although only further study will tell. Evaluations of the effectiveness of interventions delivered to specific populations will help determine whether or not this strategy is an effective means to improving patient health and
reducing healthcare costs. If interventions can reduce ED utilization cost-effectively, it is possible that health care costs could be reduced among this population.
References


165


167


doi:10.1016/j.annemergmed.2016.05.021


doi:10.1371/journal.pone.0124552


Retrieved from https://methodology.psu.edu/ra/lca


Volpp, K. G., & Mohta, N. S. (2016). Patient engagement report: Improved engagement leads to better outcomes, but better tools are needed. NEJM Catalyst.


Wilson, M., & Cutler, D. (2014). Emergency department profits are likely to continue as the Affordable Care Act expands coverage. *Health Aff (Millwood), 33*(5), 792-799. doi:10.1377/hlthaff.2013.0754


172


