**Distribution Agreement**

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Julia Caroline Bell Date

Medical and social characteristics of super-utilizers: A case-control study of patients frequently admitted to a Southern public hospital.

By

Julia Caroline Bell
Master of Public Health

Hubert Department of Global Health

_____

Mohammed K. Ali
Committee Chair

# Medical and social characteristics of super-utilizers: A case-control study of patients frequently admitted to a Southern public hospital.

By

Julia Caroline Bell

B.A.
George Washington University
2008

Thesis Committee Chair: Mohammed K. Ali, MBChB, MSc, MBA

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in the Hubert Department of Global Health
2015

## Abstract

Medical and social characteristics of super-utilizers: A case-control study of patients frequently admitted to a Southern public hospital.

By Julia Caroline Bell

**Introduction:** Super utilizers of healthcare services are defined as individuals who are high cost, frequent users of health services. These individuals make up a highly complex patient population that represents the intersection of public health policy, social determinants of health, rising healthcare costs, and clinical prevention and treatment. This research aims to describe characteristics of the patient population at Grady Hospital that qualifies as super-utilizers of Grady's inpatient services. It also aims to provide an epidemiological model that explains which patient characteristics are independently associated with higher odds of becoming a super-utilizer.

**Methods:** We conducted a case-control study of high utilizer patients at a public hospital in Atlanta, Georgia. Cases were defined as patients with three or more inpatient admissions in a calendar year; age- and sex-matched controls had one or two admissions in a calendar year. Data was collected via retrospective chart review. Logistic regression models were developed to determine patient factors that contribute to higher odds of high utilizer patient (HUP) status. A second logistic regression pooling cases and controls was conducted to determine if HUP status independently contributed to increased mortality.

**Results:** Patient factors contributing to high utilization of inpatient services included both clinical and non-clinical characteristics. Adjusted for socio-demographic, clinical, and social factors, Medicaid beneficiaries were five times more likely to be high utilizer compared to controls (OR 5.217, 95% CI 1.902, 14.305). History of substance use and homelessness were also significantly associated with HUP status (OR 2.641, 95% CI 1.268, 5.501; OR 2.906, 95% CI 1.122, 7.530, respectively). Clinical conditions contributed between nearly two and nearly six times higher odds of being a high utilizer patient. HUP status was also found to contribute to higher mortality, with high utilizer patients having more than twice the odds of dying compared to non-high utilizer patients, despite all other factors being considered.

**Discussion:** The high utilizer patient population at Grady has not only significant medical comorbidities, but also clear social barriers that result in high health services utilization. Coordinated care interventions can address both issues and have the potential to improve patient health while decreasing costs.

# Medical and social characteristics of super-utilizers: A case-control study of patients frequently admitted to a Southern public hospital.

By

Julia Caroline Bell

B.A.
George Washington University
2008

Thesis Committee Chair: Mohammed K. Ali, MBChB, MSc, MBA

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in the Hubert Department of Global Health
2015

**Acknowledgements**

First and foremost, to Dr. Mohammed Ali: thank you for the immense support you offered me throughout this process. You guided my thinking, encouraged me during moments I felt particularly hopeless, and challenged me to produce the best work possible. Your mentorship during my time at Rollins has been invaluable, and I am a better thinker, writer, and public health practitioner for it.

To Dr. Turbow, I extend my deepest thanks. You are an integral part of the work produced here and it quite simply would not have been done without you. Thank you for trusting me with this project.

To Dr. George – thank you for humoring me when I approached you as a first year graduate student and offered my help with any (truly, any) projects you were working on. You gave me the opportunity to do meaningful work for a population you care deeply about, and for that I will be eternally grateful.

These acknowledgements would not be complete without crediting both my family and friends, whose unrelenting support and cheer these past ten months lifted my spirits and gave me the motivation to see this through. At the risk of sounding trite, I am incredibly lucky to have you all in my life. To my mother and Caitlin especially: you made me laugh and put things in perspective. Thank you for keeping me (relatively) sane.

Lastly, to Jolian – I imagine the relief you'll feel when this is over will rival mine. None of this would have been possible without you and the love and patience you show me every day. Thank you for seeing me through this adventure, and all those to come.

## TABLE OF CONTENTS

## I. INTRODUCTION

The fact that health care costs are rising in the United States is well established[1]. Concerns about rising costs have resulted in a wide range of efforts aimed at reducing these expenditures, including national policies like the Patient Protection and Affordable Care Act, patient-centered care practices within health systems, evidence-based care protocols that marry high quality care with cost reduction, community-based behavioral interventions, and research emphasizing the identification of the highest cost patient groups [2-4]. These patient groups are a natural group to target: they are a small population who incur a substantial proportion of health costs[5]. It seems logical that the best strategy to reduce costs is to intervene on this patient population, however simply using cost as an indicator for utilization can be overly simplistic. The reason for this is that cost hides all manner of cause and, subsequently, opportunities for intervention.

Take the example of two hypothetical patients. The first is a young woman who is in a serious car accident; she is well-off, insured, employed, wears her seatbelt, but due to some ill-fated encounter with a brash driver, she winds up in the hospital for an extended period of time incurring astronomical medical bills. The second patient is a middle-aged man who is sporadically employed, a Medicaid beneficiary, and has uncontrolled hypertension and diabetes. He doesn't take his medications regularly, hasn't made any recommended lifestyle changes, and winds up hospitalized four times in one year due to complications from his chronic conditions. Looking at cost alone, one may decide to intervene on the first patient - but how? What could have been done to prevent her accident? And, more importantly, there is a very low likelihood that she will suffer another similar accident and become a high-cost patient again. The second

patient, however, is prime for an intervention that can address his medical and social needs and potentially prevent him from having multiple future hospitalizations.

This research focuses on the specific sub-set of patients that this man belongs to - individuals who are both high cost and regular high users of health services; not those with one-off high-cost encounters with the health care system. There exists a need to understand, describe, and provide recommendations for high-user patients. This research aims to do just that, first by providing the economic and social context behind these so-called 'super-utilizers', and then examining the characteristics of a cohort of patients at a safety net hospital in Atlanta, Georgia.

*Problem Statement*

Super-utilizers are a highly complex patient population that represents the intersection of public health policy, social determinants of health, rising healthcare costs, and clinical prevention and treatment. These patients are arguably the highest need members of society, often marginalized, and consistently facing challenges that compromise their physical health and overall well-being. Much attention is given to these super-utilizers, however the epidemiological evidence describing them is still young. Such a gap can keep researchers, policy makers, program directors, and health systems from being able to understand the key characteristics and needs of these patients, which in turn prevents the development of intervention programs and early identification of super-utilizers.

Grady Health System in Atlanta, Georgia has a large population of super-utilizers, however it does not currently have any epidemiological data that describes these patients and what makes them more likely to be super-utilizers. Given Grady's status as a public hospital that serves the highest need citizens of Atlanta, exploring the demographic, social, and medical

factors that contribute to preventable utilization of Grady's inpatient services will help to design appropriate interventions for this high-cost, high-need population.

*Purpose Statement*

The purpose of this research is twofold. First, we aimed to describe characteristics of the patient population at Grady Hospital that qualifies as super-utilizers of Grady's inpatient services. Second, we aimed to provide an epidemiological model that explains which patient characteristics are independently associated with higher odds of an individual becoming a super-utilizer. In addition to providing insights into risk factors for excess utilization, the model is also designed to serve as a precursor for a predictive model that can identify future high utilizers at Grady Hospital. Specifically, this study asks:

- What are the demographic, social, and medical characteristics of Grady's super-utilizers?
- Which of these characteristics contribute to being a super-utilizer?

*Significance Statement*

The knowledge gained in this study has the potential to have meaningful impacts on high-need individuals in the Atlanta area. Understanding super-utilizers at Grady will allow for improved patient outcomes, not only clinically, but also socially and behaviorally. There is a potential that, by identifying and building an intervention aimed at super-utilizers, these patients will not only incur less future costs but will see a dramatic improvement in their overall well-being, self-perceived health, and security within their social and structural environment. In addition to improving individual quality of life - the highest goal in public health and medicine - the success of any interventions is based on its potential to decrease healthcare costs, inspire

collaboration and programming at other similar hospitals to decrease fragmented care of super-utilizers, and can even inform local and state policies related to care for the indigent, including Medicaid expansion. In sum, the knowledge gained here can do what public health often aims to do: effect change at the individual, community, and policy levels simultaneously to the benefit of people and systems alike.

## II. FORMAL REVIEW OF THE LITERATURE

### *Dimensions of Healthcare Costs*

Our discussion of costs is largely limited to direct medical costs – i.e. expenditures on health services (outpatient visits, inpatient stays, diagnostic tests, medications, and procedures) and does not include non-medical costs (e.g., transportation to health facilities) or indirect costs (e.g., lost productivity) of ill health.

Health care expenditures are highly skewed to the top 5% of the population, who account for half of all costs, with annual expenses averaging over $43,000 [6]. These top five percent spend more than seventeen times what the bottom fifty percent spend on healthcare annually, and are more than ten times likely to report being in only fair or poor physical health than the same bottom fifty percent [7]. Digging deeper into the expenditure distribution, one finds even greater disparities in costs. For example, the top 5% accounted for nearly 75% of costs related to heart disease and cancer, and 40 to 60 percent of costs related to treatment for trauma, mental health issues, and asthma [5]. Patients with multiple chronic conditions, hospital admissions, and hospital readmissions are three major contributors to high health care expenditures.

A person has multiple chronic conditions (MCCs) when they have a combination of at least two chronic diseases, such as chronic obstructive pulmonary disease (COPD) and diabetes,

or chronic kidney disease and hypertension [8]. In the United States, nearly 25% of adults - and nearly 67% of Medicare beneficiaries - have MCCs [8]. The combination of chronic diseases result in significantly higher costs: on average, patients with MCCs have health expenditures up to seven times more than patients with one chronic disease [8]. For example, while the top 5% of costly patients with one chronic condition incur costs averaging approximately $32,000 annually, the top 5% of patients with four or more chronic conditions incur annual costs of over $78,000 - more than double the already highest-cost patients without MCCs [5].

Multiple chronic conditions result in increased hospitalizations, increased hospital costs, and increased mortality. In 2009, nearly 70% of the 28 million hospital discharges, aside those related to pregnancy and maternity, were patients with MCCs [9]. 78.1% of patients with MCCs were projected to have hospitalizations in 2014, up from 63.1% in 2003. Compare this to patients without MCCs: 22% were projected to be hospitalized in 2014, down 15% from 2003 [8]. By these estimates, patients with MCCs were hospitalized 3.5 times more in 2014 than those without MCCs [8]. Hospital costs for patients with MCCs are also nearly 20% higher than those with no or one chronic condition, with MCC-hospitalization costs increasing from $12,000 per stay in 2003 to $14,500 per stay in 2014 [8]. Differences in mortality between patients with and without MCCs are also significant: adults with more than three chronic conditions who were discharged from inpatient care in 2009 had a mortality rate of 3.1%, while adults discharged with zero or one chronic disease had a mortality rate of 1.9% [9].

Medicare and Medicaid bear the brunt of costs related to MCCs. Medicare beneficiaries had the highest prevalence of four or more MCCs in 2009 (74.8%), while only 16.7% of privately insured patients had four or more MCCs in the same year [9]. While younger Medicaid beneficiaries had lower rates of having four or more MCCs, this prevalence increased among

beneficiaries as age increased, reaching 32% for patients aged 45-64 years and 42% for patients older than 64 years [9].

Health care costs are not evenly distributed by type of service, either, with hospitalizations as one of the most costly forms of health care. While only 7% of the population was hospitalized in 2011, the associated costs of inpatient care made up one third of all health care spending in the United States [1, 10]. Hospital costs are also increasing, with an average cost of $10,400 per stay in 2012 and projections for continued increases in cost [1, 11]. Like expenditures associated with MCCs, public insurance programs like Medicare and Medicaid pay for most hospital stays. In 2012, there were $377.5 billion in inpatient hospital costs, with 46% and 16% covered by Medicare and Medicaid, respectively [10].

Hospital readmissions, often considered an indicator of patient care quality, are another significant contributor to health care costs. In 2011, there were over 3 million readmissions within 30 days of discharge in the United States, and cumulatively, these were associated with over $41 billion in cost [12] . The causes for readmission varied by type of payer. Medicare patients were most likely to be readmitted due to congestive heart failure, sepsis, and pneumonia; Medicaid patients were readmitted due to mood disorders, schizophrenia, and diabetes; and patients with private insurance were readmitted for elective chemotherapy, mood disorders, or complications from surgical or medical care [12]. Privately insured patients were also readmitted at a lower rate compared to Medicare beneficiaries, at 8.7 readmissions per 100 admissions and 17.2 readmissions per 100 admissions, respectively [12].

Clinical reasons often appear to be the easiest explanation for rising health expenditures: chronic disease rates are increasing, and medical technology is becoming more advanced and more expensive. While clinical reasons are, naturally, contributors to cost and utilization of

health services, to end inquiry of cost-driving utilization at the clinical level can be reductive and one-dimensional. Instead, one must acknowledge that rising healthcare costs are multilayered and multifactorial. To truly understand the causes behind excess utilization of health care services one must go beyond clinical factors and acknowledge that demographic and social factors can be contributors - or barriers - to good health.

*Andersen Healthcare Utilization Framework*

A person's actions are often the result of a combination of individual and social elements; these elements can influence myriad aspects of someone's behaviors and decisions - whether or not they graduate high school, their decision to smoke, or choosing to engage in risky behaviors like unsafe sex. Health care utilization is, similarly, the result of an individual's decisions and behaviors that in turn are influenced by personal and social factors. Choosing to visit an emergency department, showing up to scheduled primary care provider appointments, refilling medications when they run out: these are behaviors, and to change someone's health care utilization, one must do what public health most often aims to achieve: effect behavioral change.

Approaching non-clinical factors that contribute to health care utilization can be a daunting process if done without a guiding theoretical framework. Frameworks can help illuminate how different individual and social elements influence health behaviors, and often focus on personal aspects like demographics, health beliefs, and social structures [13]. Ronald Andersen proposed one of the most prominent frameworks explaining determinants of health service utilization. This framework focuses on health service utilization from the individual perspective, and posits that utilization behavior results from individual-level predisposing, enabling, and clinical characteristics [14]

Predisposing factors are underlying characteristics that are foundational determinants of health care utilization. Predisposing characteristics are broken into three sub-characteristics: demographics, social structure, and beliefs. Demographics include characteristics such as age, sex, and marital status. Past illness is also included in demographics; Andersen argues that these past illnesses are predisposing because evidence shows that individuals with previous health issues are more likely to use health services in the future [14]. Social structure variables are designed to show the individual's place within their immediate and extended community, as well as their surrounding social environment. Education, race, occupation, and religion are some characteristics within social structures that can influence a person's health-seeking behavior and predispose them to high utilization of health services [14]. Health beliefs are the last sub-characteristic of predisposing factors. This sub-section captures an individual's values as they pertain to health and illness, perceptions of health care services, and understanding and knowledge of disease. Andersen argues that, like the other predisposing characteristics, health beliefs are not a direct cause for health-seeking behaviors, but may play determining roles in someone's proclivity to use health services [14].

Enabling characteristics are those factors that make health care services more or less available to an individual. These characteristics are broken into sub-categories that detail family level and community level enabling factors. On the family level, income, health insurance, type of regular health care, and access to regular health care are the key enabling characteristics that influence a person's ability or decision to seek care [14]. Enabling community factors speak more to structural characteristics that influence health care availability, such as the amount of available health care personnel, the cost of care, and geographic factors like region and

rurality[14]. The community level factors in particular are often outside the individual's control, and speak to the fact that the structural environment often impacts individual's behaviors.

Illness level is the most immediate determinant of health care utilization in Andersen's model. This determinant is divided into perceived and evaluated illness, which have some overlap. Perceived illness includes disability, symptoms, diagnoses, and general state; evaluated illness includes symptoms and diagnoses [14]. How individuals view their overall health, experience their symptoms, and judge their illness shapes their perceived need of health care services, and is a large influencer of care utilization [15]. Key here is the difference between an individual's perception of their health and a provider's perception of patient health. In the Andersen model - presuming predisposing and enabling conditions exist - an individual or their family must perceive illness, or threat thereof, to use health care services [14]. Understanding an individual's perception of their illness and need can shed light on utilization patterns, and provide an opportunity for intervening on this perception to decrease excess utilization.

When considering high healthcare costs and excess utilization in the context of direct clinical factors combined with the determinants modeled in Andersen's framework, one can appreciate the complexity of super-utilization. While some patients may become high-cost super utilizers due to acute trauma or accidents, some are individuals whose excess utilization stems from an entanglement of individual, social, and clinical factors. These super-utilizers have needs that extend beyond medical care, and are prime targets for interventions that can reduce preventable health care utilization.

*Super-Utilizers: Complex Needs and Preventable Use of Healthcare Services*

High utilizing individuals with complex social needs, barriers to good health, and existing medical issues have garnered increased attention in recent years. Popular attention to these super-utilizers was most prominently drawn by Atul Gawande's 2011 New Yorker article, "The Hot Spotters." Gawande, a prominent physician and writer, profiled Dr. Jeffrey Brenner, a family medicine doctor in Camden, New Jersey. Dr. Brenner employed hot-spotting techniques traditionally used by police officers for crime mapping, and began mapping Camden-area patients with high cost related to use of EDs and inpatient services [16]. Brenner found that the most expensive patients were concentrated on two blocks, one with a nursing home and one with a public housing tower; over 6 years, the two hundred people in those buildings accrued $200M in hospital costs and had over 4,000 hospital visits [16]. What's more, Brenner found that of the 100,000 patients who used Camden medical facilities, the top 1% accounted for 30% of all expenditures [16]. Once Brenner identified the highest-cost patients, he began intervening on these patients one-on-one. He found that the highest cost patients did not simply have acute medical needs, but also had issues with substance use, poor social support, insecure housing, and low health literacy [16]. In 2009, Brenner founded the Camden Coalition of Healthcare Providers, an organization dedicated to helping super-utilizer patients address personal and social barriers to good health and reducing preventable utilization of health services [16]. The effort has been successful: the Coalition's first thirty-six patients averaged a combined 62 hospitalizations and ED visits per month, however after Brenner's team intervened these numbers decreased 40%, to only 37 monthly visits. Hospital bills also decreased significantly, from a combined monthly total of $1.2M to slightly over half a million per month [16]. Today, the Camden

Coalition is at the forefront of interventions related to super-utilizers, and serves as a national model for efforts targeting super-utilizers.

The Center for Medicare and Medicaid Services describes super-utilizers as "beneficiaries with complex, unaddressed health issues and a history of frequent encounters with healthcare providers" [17]. They receive fragmented care, typically in more acute settings such as EDs and hospitals, while access to primary care is limited [17]. Many are insured through Medicaid or not at all, are disabled or unemployed, or do not receive employer-provided insurance [18]. Social and behavioral barriers are significant: super-utilizers are more likely to be homeless or have insecure housing, have substance abuse issues, or suffer from mental illness [17, 18]. These social barriers mirror the obstacles Dr. Brenner and his Coalition identified in Camden's super-utilizers, and further support Andersen's theory of predisposing and enabling determinants of health service utilization.

Super-utilizers are also characterized by their utilization of emergent or inpatient healthcare services for conditions that can be managed and prevented by self or primary care. In 2012, six out of the ten top diagnoses for Medicaid beneficiaries - who are well represented within super-utilizers - were ambulatory care sensitive conditions (ACSCs) [19]. ACSCs are diseases that can be prevented or well-managed in primary care settings, such as diabetes, COPD, and pneumonia [19]. These conditions are also common causes for readmission to inpatient services by Medicare and Medicaid beneficiaries, demonstrating the need for better primary care and early intervention for super-utilizers [9].

Reasons for hospital admissions and inpatient stays can also reflect the social and behavioral barriers facing super-utilizers. Medicaid super-utilizers are commonly admitted for alcohol withdrawal or mood disorders [20]. Patients coming from low-income neighborhoods are

admitted to hospitals at a higher rate than their higher-income counterparts and have longer lengths-of-stay, indicating the impact community-level factors can have on health service utilization [11]. Homeless patients have a higher prevalence of both acute and chronic conditions, and are more likely to be frequently admitted to inpatient services and with longer lengths-of-stay [21]. These social and behavioral barriers indicate that for utilization to decrease, interventions should be targeted not only on primary care and ACSCs, but also non-clinical obstacles to good health and appropriate use of services. The research in this study focuses on this specific subset of high-cost patients: individuals who have not only clear medical needs, but who may experience other challenges that result in high utilization of health care services.

*The Grady Context*

Grady Hospital is an integral part of Atlanta's health care landscape. Founded in 1822 in the Reconstruction-era South, Grady was the first hospital to treat both black and white patients. Its founding mission was to serve poor patients and provide emergency medical care, a mission it maintains today [22]. It is the largest public hospital in the Southeast, and the sixth largest nationwide [23, 24]. It has over 950 beds, more than 200 specialty and subspecialty clinics in the Atlanta area, and 17 operating rooms [23]. In 2013, Grady Hospital had 126,000 ED visits and 600,000 outpatient visits [25]. One in three babies born in Atlanta are born at Grady, and its physicians treat more indigent patients than any other hospital in Georgia [22, 26].

Public hospitals like Grady historically serve lower income patients. While members of the National Association of Public Hospitals, of which Grady is part, make up only 2% of all hospitals, they account for 25% of uncompensated care in the United States [26]. In 2010, 19.4% of Georgia residents - approximately 1.9 million people - were uninsured, and Georgia has not

yet chosen to expand Medicaid services under the Affordable Care Act [27]. Given's Grady's status as a safety-net hospital that serves lower income populations, assuming that Grady has a relatively significant burden of uncompensated care is not an unreasonable leap [22]. Medicaid expansion would positively impact Georgia, and by extension, Grady, as more people would have health insurance coverage and uncompensated care would decrease.

Beyond uncompensated care, payment systems at Grady rely primarily on federal safety nets and county taxes. Rates of uninsured patients at Grady are not publicly available, but a 2008 New York Times article reported that one third of patients at Grady had Medicaid and only 8% were privately insured [26]. Financially, Grady depends on Medicaid and Medicare payments, as well as local funding, to stay afloat [22]. Only Fulton and Dekalb counties provide funding for its indigent patients at Grady, and most of Grady's patients are drawn from these counties [22]. However, given Grady's status as a Level 1 Trauma Center with premier burn and stroke units, Grady often admits patients from all over Georgia who are in need of critical care [22]. While 5% of patients come from counties outside of Fulton and Dekalb, none of these counties currently provide any funding to Grady for indigent care [22].

Given Grady's status as a health care provider for a broad range of patients across metro Atlanta, its setting for a study of super utilizer patients is natural and relevant. The need for research of high utilizer patients that goes beyond clinical factors is apparent, and often those with the highest use also have the most social obstacles and greatest marginalization. Grady serves not only those with acute medical needs, but also people with significant barriers to health care such as homelessness, substance abuse, and social instability. Conducting a case-control study in this context allows for illumination of demographic, social, *and* medical risk factors that result in high utilization of Grady's inpatient services.

## III. METHODS

### *Study Design*

A case-control study design was selected for this research due to the retrospective nature of data collection and the research aim of identifying potential risk factors leading to high utilization. This particular design is well suited to the study's aims as it allows researchers to determine which characteristics increase the odds of high-utilization and match on potential risk factors to control confounding. Case-control studies are also beneficial for exploratory research, aligning with this study's goal of creating a model that can inform future predictive risk scores that identify super-utilizers.

### *Data Source*

Patient data were collected from Grady Hospital's Electronic Medical Record (EMR) system. Within patient EMRs, the most common data sources were:

- History and Physicals (H&P): a document summarizing subjective and objective patient data, taken at time of admission, which includes patient medical histories, current complaints, social history, anthropometric and vital sign data, and physician assessment and plan.
- Discharge Summaries: a summary of the patient's hospitalization, including treatments, diagnoses, and planned dispositions.
- Social Worker Notes: documents written by hospital social workers summarizing patient interviews related to personal factors affecting health and well-being, including substance use, housing status, insurance status, and any other issues that might impact a patient's treatment or disposition.
- Nursing Administrative Summary: administrative document summarizing historical patient information, including anthropometric data, diagnoses, and social histories.

*Study Population*

Cases and controls were identified through a master list of patients who visited Grady's Emergency Department (ED) from 2010 to 2013 in Atlanta, Georgia. This list included a patient's Medical Record Number (MRN), as well as their disposition (admitted, discharged, etc.). The research team defined health care utilization by the number of admissions to inpatient services in one calendar year, and used the master list to identify the top 5% and 1% of patients admitted to Grady. The top 5% of users amounted to 3,000 individual patients who were admitted three or more times in one calendar year between 2010 and 2013. 600 patients were in the top 1% of utilizers, with five or more admissions per year. For the purpose of this analysis, high utilizer patients are defined as those with three or more admissions to inpatient services in a calendar year.

A total of 250 cases were randomly selected from the overall cohort of the 3,000 patients defined as the top 5% of users. Random sampling allows for a representation of all high use patients and avoids selection bias [28]. Inclusion criteria for the initial sample of 250 deemed eligible any patient with three or more admissions from 2010 to 2013. However, in 2010 Grady adopted an EMR system, and the migration to EMRs resulted in incomplete 2010 patient charts. Forty-five patients whose year of high utilization was 2010 only were excluded from the sample due to these incomplete charts. Fourteen patients whose index year of high use was 2010 were included due to a subsequent year of high use, using their records from that respective year for analysis. A second random sample was pulled from the cohort of 3,000 to replace the 45 excluded 2010 patients, this time drawing from 2011 to 2013.

Undocumented immigrants with admissions related to receiving hemodialysis for end-stage renal disease (ESRD) were excluded from the sample. Historically, undocumented ESRD

patients are high-users of inpatient health services due to their ineligibility for Medicare, which covers hemodialysis for any U.S. citizen with ESRD. While this particular population is represented in the top 5% of users at Grady, the interest of this specific analysis centers on the different factors that contribute to high health care utilization across a general population. Removal of the three undocumented ESRD patients from the sample of 250 resulted in a final random sample of 247 cases.

Controls were defined as any patient with one or two inpatient admissions in a calendar year. Control patients were selected on a 1:1 ratio from the same master list of patients, matching on age, sex, and year of high use. If multiple control patients for a given year matched a case on age and sex, a random number generator was used to select the control. 247 controls were included in this analysis.

IRB approval was required for this research given the sensitive and identifiable nature of patient medical records. IRB approval was granted first by Emory University, which counts Grady as one of its partners in academic medicine. Grady's Research Oversight Committee (ROC) granted a second level of IRB approval. Access to patient EMRs via Epic Software was granted once IRB and ROC approval was confirmed.

*Data Collection*

Patient data was collected through retrospective chart review conducted from October 2014 through February 2015. Chart abstraction was done in accordance to the study protocol, available in Appendix A. Given that data collected covered a range of demographic, social, and medical information, chart abstraction was divided between a graduate MPH student and the study's Chief Investigator, a third year Internal Medicine resident at Emory University. The

graduate MPH student collected all data related to demographics, anthropometrics, social history, outpatient medical visits, and admission/disposition information. The Chief Investigator collected all data related to past medical history, imaging, surgery, medications, inpatient procedures, and reasons for admission. Data collection was divided in this way to avoid any errors that could result from incorrect interpretation of medical information on the MPH student's part.

Demographic data collected from administrative records included the following: sex, birthdate, race/ethnicity, street address, county, zip code, and whether or not the patient was deceased. Patient birthdate was used to assign patient age, calculated as the patient's age at index admission in their year of high use. Race was assigned based on the stated ethnicity in the patient records. Zip code data was used to collect median household income level, provided at the zip code level by the U.S. Census Bureau's 2009 - 2013 American Community Survey 5-Year Estimates [29]. Patients were defined as deceased under two conditions: if the patient passed at Grady Hospital, or if the patient was discharged to hospice during their year of high use. Given the possibility that patients were discharged to hospice in subsequent years, or passed away outside of Grady Hospital, the statistics on deceased patients are likely conservative estimates.

Anthropometric data were collected for the purpose of calculating BMI. Height and weight data were taken from the patient's most recent H&P during their year of high use, and were measured in inches and pounds, respectively. If height and weight was not available in the most recent H&P, previous H&Ps were reviewed for the most recently available anthropometric information. Data were cross-checked against the Nursing Administrative Summary in patients' EMRs to ensure consistency and resolve any discrepancies. BMI was calculated with the following conversion formula: ([weight]/[height]*[height]))*703.

Socioeconomic characteristics including housing, employment, incarceration, and insurance information were collected to obtain non-medical factors that could contribute to high use. Employment data was collected from H&Ps, social worker (SW) notes, or the patient's administrative chart. A patient was considered employed if any positive mention of employment was made in any of the reviewed sections; classification of unemployment met the same criteria. If no explicit mention of employment was made in throughout the patient record, the employment status was classified as "Not Specified." Patient homelessness was determined from H&Ps and SW notes, as was current incarceration or history of incarceration. As with employment status, patients were only classified as homeless, incarcerated, or with a history of incarceration if there was an explicit inclusion of this fact in the patient record. For example, a patient was classified as homeless if they were admitted from a shelter, brought in by police enforcement who classified the patient as homeless, admitted to homelessness, or was discharged to a shelter. A patient was defined as insured if they had health coverage during any portion of their year of high use; specific payer information was collected from the administrative discharge summaries from that respective year.

Patients' social habits, which included alcohol, tobacco, and substance use, were also collected from H&Ps and SW notes. Substance use included the use of marijuana, crack/cocaine, heroin, methamphetamines, or other (e.g. household chemicals). Current use was defined as a positive test or admission of use during any patient interview. History of use was deemed positive if a patient had either positive current use or positive prior history of use (e.g., if a patient was a current every-day smoker, or if a patient smoked for 30 years but quit 5 years prior to admission). Negative use was defined as both explicitly stated negative use as well as no statement of use.

Admitting information included the number of ED visits and admissions during the year of high use, admission and discharge dates, whether a patient left against medical advice (AMA), admitting service, and disposition to either home care, nursing home, sub-acute rehabilitation (SAR), or hospice. Number of ED visits was collected by counting the number of days a patient visited the ED during their year of high use, and included ED visits that resulted in an admission. Number of admissions was collected by counting the number of H&Ps for any inpatient service during the specified year of high use. Admission and discharge dates were collected from the administrative discharge summary, and were used to calculate both length of stay and time to next admission. Admitting service was collected from H&Ps, and AMA and disposition data were both collected from medical discharge summaries.

Medical information included all current and past medical diagnoses, reasons for admission, number of outpatient medicines prescribed, types and number of imaging, types and number of surgeries, hemodialysis status, mental health referrals, and whether the patient had home oxygen, a tracheostomy, a feeding tube, or a Foley catheter. Current and existing medical diagnoses were pulled from H&Ps and discharge summaries, and reasons for admission were pulled from medical discharge summaries. Number of outpatient medicines prescribed was defined as the total count of outpatient prescriptions in a calendar year; different formulations of the same medication (e.g., Atorvistatin and Rosuvastatin, two statin formulations) were counted separately, however different dosages were not. Types of imaging included x-rays, ultrasounds, computed tomography (CT) scans, positron emission tomography (PET) scans, magnetic resonance imaging (MRI), and interventional radiology (IR) procedures. Echocardiograms, both transthoracic and transesophageal, were counted as ultrasounds. The number of each type of imaging for year of high use was also recorded. Types of surgery included biopsies,

esophagogastroduodenoscopies (EGDs)/colonoscopies, bronchoscopies, cardiothoracic, abdominal, orthopedic, vascular, neurologic, heart catheterizations and other (e.g. ocular, gynecologic). Number of each type of surgery for year of high use was also recorded. Hemodialysis status, mental health referrals, home oxygen, tracheostomy, feeding tube, and chronic Foley catheter information was all drawn from H&Ps and/or medical discharge summaries. Patient information abstracted from EMRs was stored in RedCap, a HIPPA-compliant database designed to store and manage patient data [30].

*Analysis*

This preliminary analysis includes 494 cases and controls. SAS software (SAS Version 9.2, Cary, NC) was used for all statistical analyses. Descriptive analyses were used to compare cases and controls' demographic, social, and medical characteristics. Chi-square tests of homogeneity and independent t-tests were used to determine statistically significant differences between cases and controls for categorical and continuous variables, respectively, at an alpha level of 0.05.

Patient diagnoses and race were both converted to new covariates for analytical purposes. Medical diagnoses were first entered into data collection as they originally recorded in the patient EMR. To facilitate analysis, diagnoses were then categorized into one of thirteen disease categories based on organ system. For example, congestive heart failure was categorized as a cardiac condition, while leukemia was categorized as a hematologic disease. A full list of both case and control diagnoses and their corresponding disease category can be found in Appendix B. Race was converted to a dichotomous covariate (Black and Non-Black).

The primary outcome of interest in this study was the dichotomous high-utilizer patient (HUP) status, defined as having 3 or more admissions per year. Exposures were demographic, social, and medical factors, which included: race, community income level, insurance status, history of tobacco use, history of alcohol use, history of substance use, homelessness, history of incarceration, and medical diagnoses by disease category (neurological, cardiac, pulmonary, gastrointestinal, hematological, renal, gynecological/urological, musculoskeletal, psychiatric, and endocrine conditions, infectious diseases, trauma, BMI, and other conditions). A secondary outcome of interest was mortality, which used the definition of deceased described previously. Exposures for this outcome were: age, sex, HUP status, and all additional demographic, social, and medical covariates described above.

Logistic regression was used to investigate the associations between covariates and HUP status. Age and sex were not included in the multivariate model given cases and controls were matched on these variables, however sensitivity analyses were conducted to ensure point estimates were not affected by this exclusion.

Univariate and multivariate regressions were run to determine associations between covariates and high utilizer status. First, each covariate was entered into preliminary bivariate logistic regression models to determine the association with positive HUP status. Covariates were then grouped into thematic categories: the first group contained demographic information (age, sex, race, community level income), the second group contained insurance payer information, the third was social history (alcohol, tobacco, and drug use, homelessness, history of incarceration), and the fourth was medical history (diagnoses grouped by organ systems). Four logistic regression models were created that adjusted for each thematic group: first for group one; then groups one and two; then groups one, two, and three; and finally all four covariate groups.

Alpha was set at 0.05 and, in addition using odds ratios and confidence limits as measures of association, r-squared values were used to determine the variance explained by each model.

A parsimonious model was created using forward stepwise selection using the fully adjusted logistic regression model. Given the model's purpose as an exploratory predictive model to identify high utilizer patients, the significance level for entry into the model was set at 0.10 [31]. The Hosmer-Lemeshow Goodness of Fit Test was used to evaluate the model's fit, and r-squared values were used to determine the total variance explained by the parsimonious model.

A second logistic regression model examining the association between HUP status and mortality, with adjustment for patient demographic, social, and medical factors was also conducted. A sensitivity analysis was also conducted in which we excluded HUP status from the model to determine whether point estimates of associations between other demographic factors and mortality changed.

Methods for this analysis mirrored the regression for HUP status, with four models that adjusted for different demographic, insurance payer, social, and clinical factors. Given that matching on age and sex was based on the original research question exploring what factors contributed to high utilization, and not mortality, age and sex were included in the logistic regressions analyzing mortality.

## IV. RESULTS

Demographic and social characteristics of the patients included are presented in Table 1. Tests of homogeneity and independence show significant differences between identified HUPs and those patients in the control group. For example, more than 33% of all cases were in the

lowest income quartile, compared to only 22% of controls. High utilizers were also more likely to be insured compared to controls (72.87% vs. 63.16%).

Social histories varied significantly between cases and controls. Rates of homelessness were significantly higher in cases than controls, at 19% vs. 4.5%, respectively. Substance use was also more likely among cases: 36.4% of high utilizers had a history of substance use, compared to only 12.6% of controls.

There were significant differences between case and control medical history in nearly all disease categories (Table 2). Chronic diseases were particularly more prevalent among cases than controls; for example, 61.3% of HUPs had some form of hematological condition, while only 17% of controls had any condition in this category. Cardiac conditions, however, were prominent in both cases and controls, with a prevalence of 82.6% and 61.5%, respectively. More acute and ad hoc conditions, such as history of trauma or musculoskeletal diagnoses, including fractures, did not vary significantly between case and control groups.

Additional outcome measures were collected beyond number of admissions in a calendar year to further demonstrate differences in health care utilization between cases and controls (Table 3). In addition to number of admissions, there were significant differences in health care utilization as measured by ED visits and outpatient medications. High utilizer patients were also less likely to be discharged to home care, with higher rates of dispositions to sub-acute rehabilitation and nursing homes. Both length of stay and time to readmission were similar between groups.

Multivariable logistic regression models were developed to understand which patient factors contributed additional odds of becoming a high utilizer (Table 4). The first model examined demographic factors associated with high use, and found that non-Hispanic Black

race/ethnicity and lowest median community household income were associated with higher odds of being a high utilizer patient (OR 1.927, 95% CI 1.162, 3.196; and OR 2.155, 95% CI 1.286, 3.610, respectively). The second model identified Medicaid and Medicare beneficiaries had three times higher odds of having HUP status compared to other insurance beneficiaries (95% CI 1.674, 6.801; 1.536, 6.742, respectively), even adjusted for race/ethnicity and household income. The third model, which additionally accounted for patient social factors, found that patients with a history of substance use had nearly three times the odds of being a high utilizer patient (OR 2.797, 95% CI 1.609, 4.863), while homeless patients were over three times more likely to be high utilizers (OR 3.538, 95% CI 1.640, 7.635). In the final model, which included patient medical histories, we observed that different disease categories contributed from nearly two times higher odds (endocrine conditions, OR 1.933, 95% CI 1.081, 3.457) to almost six times higher odds (hematologic conditions, OR 5.947, 95% CI 3.245, 10.897) of being a HUP. Payers and social history exposures contributed to 17.5% of the explained variance of high use, while medical history contributed slightly more, with 23% of the explained variance.

A stepwise regression was conducted to produce a parsimonious model that would serve as a precursor to a future risk score tool identifying high utilizers. The eleven covariates retained in the stepwise regression, which used an entry level alpha of 0.10, were essentially identical to the covariates that retained significance in the fourth logistic regression, which adjusted for demographic, insurance, social, and medical factors. Payer type, history of tobacco and substance use, homelessness, and hematological, pulmonary, renal, gastrointestinal, neurological, endocrine, and infectious disease categories were the covariates determined to be most parsimonious for a future predictive model. Within payer types, Medicaid beneficiaries, Medicare beneficiaries, and uninsured patients were positively associated with HUP status. For

example, Medicaid beneficiaries were over four times as likely to be high utilizer patients compared to patients with combined Medicaid and Medicare insurance (OR 4.623, 95% CI 1.800, 11.871). Positive history of tobacco use yielded a positive association with HUP status, as did history of substance use and homelessness (OR 1.720, 95% CI 1.000, 2.959; OR 2.660, 95% CI 1.378, 5.134; OR 3.047, 95% CI 1.244, 7.460, respectively). All of the retained disease categories were positively associated with HUP status, with odds ratios ranging from 4.952 for hematological conditions (95% CI 2.905, 8.440) to 1.963 for endocrine conditions (95% CI 1.153, 3.342). As insurance payer and homelessness carried the most weight for non-clinical factors, higher points will be allocated to them in the future risk score. Clinical factors that will have higher point values in the risk score will be hematologic, renal, and pulmonary conditions.

The models presented do not include age and sex as cases and controls were age- and sex-matched. In a sensitivity analysis using a multivariate regression model that included age and sex, the inclusion of age and sex did not effect which covariates retained significance in the final model. However, some magnitudes of association did change. When age and sex were added, the association between patients insured through Medicaid and HUP status weakened (from 5.217 [95% CI 1.902, 14.305] to 3.178 [95% CI 1.108, 9.116), while the association between patients insured through Medicare and HUP status strengthened (from 5.394 [95% CI 1.959, 14.584] to 5.999 [95% CI 2.076, 17.278]). Adding age and sex also strengthened the association between a history of tobacco use and HUP status (from 1.833 [95% CI 1.003, 3.352] to 1.999 (1.075, 3.718)] and homelessness (from 2.906 [95% CI 1.122, 7.530) to 3.285 [95% CI 1.235, 8.737]). The association between history of substance use and HUP status was weakened once age and sex were added (from 2.641 [95% CI 1.268, 5.501] to 2.153 [95% CI 1.012, 4.583]).

Including age and sex in the final model also slightly changed the strengths of association between patient medical histories and HUP status, but did not impact the overall significance of these covariates. Associations that were strengthened by the inclusion of age and sex were neurological conditions (from 2.682 [95% CI 1.505, 4.778] to 2.924 [1.607, 5.323]), pulmonary conditions (from 3.332 [95% CI 1.868, 5.942] to 3.695 [95% CI 2.168, 7.249]), gastrointestinal conditions (from 3.210 [95% CI 1.763, 5.468] to 3.309 [95% CI 1.790, 6.119]), hematological conditions (from 5.947 [95% CI 3.245, 10.897] to 6.348 [95% CI 3.403, 11.839]), and endocrine conditions (from 1.933 [95% CI 1.081, 3.457] to 1.965 [95% CI 1.088, 3.548]). Associations that were weakened by the inclusion of age and sex were infectious diseases (from 2.860 [95% CI 1.397, 5.856] to 2.529 [95% CI 1.220, 5.243]) and renal conditions (from 3.424 [95% CI 1.765, 6.643] to 3.374 [95% CI 1.906, 7.316])

In a logistic regression analysis examining covariates associated with mortality (Table 5), cases and controls were pooled and HUP status was treated as the primary exposure for mortality. The bivariate model showed that, compared to non-HUPs, HUP status was associated with 3 times the odds of mortality (OR 2.999, 95% CI 1.766, 5.092). As additional patient factors were introduced to the model, HUP status remained highly significant. Adjusted for demographic characteristics, insurance payers, and patient social factors, HUPs had odds of mortality that were over three and a half times higher than non-HUPs (OR 3.607, 95% CI 1.967, 6.616). Odds of mortality in HUPs were lower when medical histories were introduced to the model, but remained more than twice the odds of non-HUP patients (OR 2.334, 95% CI 1.114, 4.893).

## V. DISCUSSION

*High Utilizer Patient Characteristics*

High utilizer patients differed significantly from control patients demographically, socially, and medically. More HUPs were black, and over sixty percent lived in communities with a median household income of less than $40,000. Of these sixty percent, more than half lived in communities with estimated median household incomes of under $28,000, just over the federal poverty line for a family of four. Insurance status also varied substantially between cases and controls. For example, one unexpected finding was that high utilizers were more likely to be insured compared to controls. However, it is possible that moral hazard - the idea that those with insurance are more likely to seek health care - could contribute to this difference. Controls, however, were more than seven times likely to be privately insured compared to high utilizer patients, which could imply that controls were employed by more organizations that offered health insurance. On the other hand, more high utilizers were insured through Medicaid and Medicare. High utilizers also experienced more social barriers - they were more likely to be homeless, have a history of tobacco or substance use, or have a history of incarceration.

Clinically, high utilizer patients presented with significantly more chronic diseases, infectious disease, and mental health issues - often double the amount presenting in standard utilization patients. Nearly 50% of HUPs had any pulmonary condition, including COPD or asthma, while less than 20% of controls presented with any pulmonary condition. This could potentially parallel the finding that HUPs were more likely to have a history of smoking. One quarter of HUPs presented with infectious diseases, which included HIV/AIDS, whereas less than 9% of control had any similar diagnoses. Psychiatric conditions were present in over 36% of cases, and was exactly twice the prevalence in controls. Neurological conditions were

represented in nearly half of cases and a quarter of controls, which may reflect the care provided by Grady's Stroke Center. Controls were more likely to present with trauma conditions, especially motor vehicle collisions. Grady is Atlanta's only Level 1 Trauma Center, which could indicate that controls may be admitted for more acute conditions in comparison to HUPs.

Some chronic conditions were prevalent in both cases and controls. Cardiac conditions were common in both groups - approximately 83% in HUPs and 62% in controls. This prevalence indicates that both cases and controls could be diagnosed with more than one cardiac condition, for example congestive heart failure and hypertension, or arrhythmia and hyperlipidemia. Endocrine conditions, of which most were diabetes mellitus, were also well represented in both high utilizer patients and control groups, with a prevalence of 45% and 27%, respectively. The prevalence in both groups is above the national estimate for diabetes mellitus, and even if 10% of conditions in each respective group were non-diabetes mellitus endocrine conditions, cases and controls would still have higher rates of diabetes than the national prevalence [32]. This, in combination with the high levels of cardiac conditions, may suggest that patients who visit Grady Hospital could be in generally poorer health that the general US population.

Interestingly, mean BMI did not vary significantly between the two groups. It was hypothesized that, given the well-documented health issues relating to weight status, there might be a difference in body mass index between cases and controls, however this hypothesis was not supported by the data.

*Factors Associated with High Utilization of Grady's Inpatient Services*

The multivariate regression showed that demographic, social, and medical factors contribute to high health care utilization. While the first reaction may be that medical history is indeed important, these findings demonstrate that non-medical factors contribute substantially to an individual's odds of becoming a high utilizer patient.

The clinical conditions that had strong associations with high use are not altogether unsurprising. Hematological conditions contributed most strongly to high utilization of care. Considering that leukemia can require significant levels of care, it comes as no surprise that hematological conditions would result in increased utilization. Many more cases than controls also had anemia, a condition that has a multitude of causes, is comorbid with many chronic diseases, and affects vital organ functions [33]. Pulmonary conditions such as COPD have long been identified as a reason for increased health care utilization, and its strong associations with higher utilization found in this study remain consistent with those findings [34]. This study also classified pulmonary emboli and lung cancers as pulmonary conditions, serious diagnoses that can result in an increased need for inpatient care.

Metro Atlanta's high levels of HIV/AIDS played a significant role in health care utilization at Grady. Some areas of Atlanta have an HIV prevalence of over 5%, more than the national prevalence of some African countries [35]. These areas are predominantly low income, where poor access to care and stigma surrounding HIV may result in late detection or irregular treatment [35]. HIV also disproportionately affects black Atlanta residents. Black males have a rate of infection 4.1 times higher than white males, while black females are infected 14 times more than white females [36]. Infectious diseases were strongly associated with higher care utilization in the multivariate model. The context of HIV/AIDS in Atlanta, combined with a need

for regular care and the risk of opportunistic infections that result from HIV, could explain why patients with infectious diseases are more likely to use health care services.

The parsimonious model was designed to serve as a precursor to a risk score for identifying high utilizers, and retained covariates that represented patients' social and medical histories. That social factors such as homelessness, substance abuse, and tobacco use remained significant despite strongly associated medical factors demonstrates the need for further exploration into the non-clinical barriers to good health that result in higher health utilization. The next steps for the parsimonious model are modeling the ROC curve, obtaining c-statistics, and measuring the model's sensitivity and specificity. This should be done for not only the random sample of patients, but also for the fully abstracted population of high utilizers at Grady.

*Factors Associated with Mortality Among Patients of Grady's Inpatient Services*

The striking difference in mortality between cases and controls - 22.7% vs. 8.9% - resulted in conducting an analysis to determine which patient factors were associated with mortality, and treated HUP status as a primary exposure. High user status retained its significance in each adjusted model, indicating that frequent inpatient admissions increase the odds of mortality substantially. While there is the possibility that using the HUP variable as an exposure may result in some collinearity with other patient factors, these preliminary results point to significant disparities in mortality between 'regular' users of health care services and super utilizers who access health care services frequently and potentially have additional social barriers to health. More research should be conducted going forward focusing specifically on risk factors for mortality in super utilizers, with the end goal of informing interventions that address preventable deaths.

The analysis examining mortality included far fewer risk factors than the analysis aiming to identify risk factors for high utilizer status. Only age, hematological conditions, and BMI were associated with mortality. Not surprisingly, as age increased, the odds of mortality were higher. Higher BMI was marginally protective against mortality, which at first glance may seem surprising. However, it is possible that more patients who died were underweight as a result of terminal cancers, end-stage COPD, or end-stage AIDS. The explained variance for the fully adjusted model was low, only 14.69%. If mortality is an outcome of interest linked to high utilizer status, more research is needed that goes beyond the patient factors explored here to fully grasp what results in patient mortality.

*Andersen Framework and Consistency with Other Literature*

The finding that both social and clinical factors lead to higher use of inpatient services supports Andersen's theory of predisposing, enabling, and illness determinants of health service utilization. Demographic predisposing characteristics were represented by the inclusion of past illnesses, and had the study not matched and sex and age it is possible those characteristics could have been significant predictors in the model. The model was lacking social structure and health beliefs characteristics; including measures of these predisposing factors in future research could help explain more of the variance in health utilization. Significant enabling factors represented in the model included family factors (health insurance type), however community level factors were not represented. Lastly, illness level was well represented, with a number of evaluated diagnoses retaining significance in the parsimonious model. The model didn't include any measures of self-perceived health, which would be an insightful addition to future research on super-utilizers.

Three exposures that contributed to higher odds of HUP status do not immediately fit neatly into Andersen's framework: history of substance use, history of tobacco use, and homelessness. Substance use could arguably be part of illness levels as addiction and substance abuse are generally considered mental health issues. History of tobacco use could fall into the same argument, but may also be a predisposing characteristic. Lastly, homelessness could fit into social structure predisposing characteristics, but it could arguably also fall into enabling family determinants. If future researchers are to pursue the topic of super-utilizers based on the theory of Andersen's framework, they should aim to measure representations of all determinants and sub-determinants in the model to gain the most insight into how different individual, social, and clinical factors influence health service utilization.

The importance of history of substance use, homelessness, and history of tobacco use in this study mirror the social obstacles described in super-utilizer literature from the Center for Medicare and Medicaid Services, the Camden Coalition, and the Robert Wood Johnson Foundation [16-18]. One Canadian study analyzing high cost users in the Ontario area found that super-utilizers were more likely to be former smokers, which is in line with this study's finding that history of tobacco use was a predictor of HUP status [37]. The consistencies in this research with existing data about super-utilizers strengthen the concept that the highest-cost patients are often faced with social barriers and preventable or manageable conditions. These factors, in combination, explain excessive health service utilization behaviors, and help identify those who are excellent targets for coordinated primary care interventions.

Common causes for admission and past diagnoses among cases were predominantly chronic diseases and ambulatory care sensitive conditions, which is consistent with findings from previous analyses of both Medicaid super-utilizers, patients with MCCs, and patient-related

factors for readmission [8, 20, 34]. Complementary to the findings that many patients had several chronic conditions was the increased death rate in cases, which is consistent with research identifying MCCs as a risk factor for increased mortality [9].

*Study Strengths and Limitations*

Strengths of this study include capturing non-medical factors associated with high health care utilization, the public hospital setting, and the disease classification system. While the inclusion of clinical data is standard in multivariate models exploring health care use, many models do not incorporate patient behaviors such as substance use or homelessness. The model in this study goes beyond clinical factors and explores relevant social exposures that could impact health care use, such as substance use, homelessness, and payer information. While payer types might not immediately come to mind as social variables, they can be used as a proxy for demographic factors such as age (Medicare), income (Medicaid), and types of employment (private, employer-provided health insurance).

Conducting the study in a public hospital is another strength of this research. Most other studies occurred in private or academic medical centers, or outside of the United States in a single-payer system [38-40]. Private or academic medical centers may cater to a higher income population, and populations outside the United States are not easily comparable to US-based studies. This study's setting in a large public hospital has two particular benefits. First, it allows access to members of the population that can be harder to reach in research, specifically the homeless and incarcerated. It is also possible that Grady serves a wider range of patients that have a more diverse demographic and socioeconomic profile than patients in private hospitals.

Given this context, it is possible that this study is able to more accurately reflect factors related to high health care utilization on a population-level.

Lastly, the use of diagnostic categories by organ system may have improved the internal validity of this study. While ICD-9 codes are standard in research studying health care utilization, these codes can sometimes fail to reflect the nuances of different diagnoses. Creating diagnosis categories that reflect overall organ systems may allow for greater insight into how medical history interacts with health care use. It also allowed for improved statistical power giving the relatively smaller sample size studied here.

This study had some significant limitations that merit discussion. First, the use of a retrospective chart review is inherently limiting. Researchers have no control over data as they were first entered into the system, which is a particularly pertinent issue where medical records are concerned. While there was a standard protocol for collecting patient information, clinical settings often lend themselves to variability in data quality since there are many different healthcare providers who differ in the level of detail they capture at the time of patient interviews. These differing levels of detail can often present researchers conducting retrospective reviews with data quality issues. The research was also only limited to one hospital, and may not have captured patients who only have one or two admissions at Grady, but additional hospitalizations elsewhere in the same year.

One issue related to retrospective reviews and data quality was how to interpret patient social history information. While positive exposure to risk factors like substance use or homelessness seemed to be reliably reported, there was a mixture between reporting negative exposure and no mention of the exposure at all (categorized as “not specified” in our data abstraction process). After speaking with clinicians, the study team decided to combine negative

exposure and not specified. The rationale for this, which was provided by the clinicians, was that physicians focus on positive exposures in their reports. Since capturing social history is standard in H&Ps, the clinicians argued that exclusion does not mean the questions were not asked; instead, they interpret exclusion as a negative exposure. For example, if Patient A were to report positive alcohol use, the clinician would make note of this in the patient's H&P or social history section in their chart. If Patient A, however, reported negative alcohol use, the clinician would either report non-use, or report nothing at all.

Combining no and not specified responses does limit the validity of the study results as it introduces the possibility of misclassification bias. It is entirely possible that some physicians did not follow typical protocol and failed to report a patient's social history, resulting in this study incorrectly classifying an exposure as negative instead of positive. Results should be interpreted with caution and future research should take pains to collect social history data either cross-sectionally or prospectively as opposed to retrospectively.

Matching on age was another limitation of the study. Since age was redefined for analysis as age at index admission date, the matching was imperfect. This resulted in slight differences in mean age that were not statistically significant. Sensitivity analyses were conducted to determine the effect of these differences in age between cases and controls on the multivariate logistic regressions. The estimates produced in both models were essentially the same. The differences in age did not change the covariates that retained significance in the models, and any differences in point estimates were minor.

Another limitation resulting from the study design is the parsimonious model's generalizability. Specifically, patient medical history was not classified into a standard format such as ICD-9 codes, but instead as larger diagnostic categories based on organ systems. These

diagnostic categories have some opportunity for subjectivity and thus could produce different results based on a study designer's understanding or interpretation of different diagnoses. It should be noted, however, that this potential subjectivity should also be inherently limited given that the disease categories were created based on standard medical knowledge that should not vary significantly between practicing clinicians. For example, it would be difficult to argue that a stroke should not fall under neurological conditions, or that diabetes mellitus should not be classified in the endocrine system.

The last notable limitation to this study is the potential loss-to-follow up that resulted from the migration to EMRs in 2010. While the study was able to identify high utilizers in 2010, the incomplete charts rendered data collection for that year impossible. Patients with high use in subsequent years were captured, however information for 2010-only patients was lost. It is possible that this loss-to-follow up introduced some bias, and readers should remain cognizant of this limitation while interpreting this study's findings.

*Opportunities for Future Research*

While the insights into high health care utilization gained in this study are promising, creating a truly comprehensive model of risk factors that predict high utilizer status demands more research. There are several possible paths to take, none of which are mutually exclusive. One natural next step would be to conduct a blinded survey of patients in an inpatient service at Grady Hospital. This survey could facilitate a broader understanding of non-medical risk factors, questioning patients on items such as health literacy, educational attainment, and family support. In addition, the survey could provide concrete data about covariates explored in this analysis,

such as tobacco, alcohol, and substance use, employment, homelessness, and history of incarceration.

Qualitative data also has unique strengths that would contribute to our understanding of high utilizer patients. Semi-structured in-depth interviews with select patients could provide rich, qualitative data that would not only supplement knowledge gained from predictive models and patient surveys, but could also shed light on previously unconsidered risk factors to high utilization that could guide future research. Qualitative data also has the potential to identify areas of intervention that may not be apparent from exclusively quantitative data.

More research and validation for an exploratory predictive model is also needed. The parsimonious model first needs to be retested on the complete identified cohort of high utilizer patients at Grady and matched controls. Applying the model to the complete cohort would allow for a refined stepwise regression and subsequent predictive model and risk score, and would have a short-term benefit of refining point estimates to reflect the complete population as opposed to a random sampling. The predictive model also needs to be refined for generalizability. Specifically, the model should be tested using ICD-9 codes, as using ICD-9 codes would allow others to replicate the predictive model and further refine it for widespread use.

*Coordinated Care Interventions in Practice*

Being able to identify patients at a statistically significant risk of high health care utilization does have its benefits; however, without application and use in clinical settings, it is rendered irrelevant. For such a predictive model to actually be valuable, there must be a cooperative effort on the part of administrators, technology, and clinicians. Administrators must

support the potentially higher up-front costs that implementing comprehensive care interventions based on predictive models and research demand. Electronic health record systems must develop compatible software that could allow real-time identification of future high-utilizer patients as clinicians interview and admit patients to inpatient services. Lastly, clinicians must be willing to adopt this technology, bear the responsibility of appropriately capturing all required information and, when necessary, intervene on patients with increased risk of becoming a high utilizer.

In addition to identifying future high utilizers, hospitals must also prioritize providing appropriate support for current high utilizers that can decrease these patients' need for frequent inpatient admissions and ED visits. One intervention to decrease high utilization used across several health systems in the United States is care coordination. In this model, patient care is managed not only by the patient themselves, but also by at least one additional person who helps the patient manage their access to and use of health care services [41]. These care coordinators focus not only on the medical needs patients, such as medications, but also on social factors such as transportation issues or homelessness that may impact a patient's use of health care services [42]. While care coordinators are often nurses or nurse practitioners, social workers also play an integral role in helping patients navigate social obstacles that can result in high utilization of health services [42].

Care coordination programs aim to reduce health service utilization through active case management, promoting patient self-management, patient education, and community outreach, which can be achieved through different care coordination models [41, 43]. A review of care coordination programs targeting Medicaid super-utilizers identified eight different models of care coordination. These models cover a range of care strategies: focusing on care management at time of inpatient discharge, conducting home visits, providing patient support in the ED,

providing stable housing to homeless patients, and engaging patients in their communities are all different methods used to manage a patient's utilization of health services [43]. When implemented in real-life settings, most interventions typically use a variety of strategies and are often successful in reducing patients' use of health services [43].

In practice, care coordination is a promising intervention that can decrease excess utilization of health care. One health system developed a care coordination program run by nurse practitioners targeting high-cost, high utilizer Medicaid patients; by focusing on the patients' medical needs and social barriers to health, the program decreased ED visits from this population by 39% in one year [44]. A public hospital in Minnesota created a Coordinated Care Center, which acted as a "one-stop shop" for high utilizers and was comprised of pharmacists, physicians, social workers, and chemical health counselors, among others [45]. After one year, this hospital decreased total charges by 23%, or approximately $25,000 per patient, and decreased ED visits by 37% and inpatient stays by 25% [43, 45]. Finally, a meta-analysis of randomized control studies measuring the effectiveness of care coordination in preventing hospital admissions found that patients in the intervention group had a significantly lower risk of being admitted to inpatient services (RR 0.81, 95% CI 0.72 - 0.91) [41]. This meta-analysis also identified case management, team changes, self-management promotion, and patient education as the strongest strategies to prevent admissions [41].

*Concluding Remarks*

The results from this study, as well as the demonstrated success of care coordination programs and their various models, should serve as an impetus for Grady Health Systems to examine opportunities for a coordinated care intervention. The high utilizer patient population at

Grady has not only significant medical comorbidities, but also clear social barriers that can result in high health services utilization. Coordinated care interventions can address both issues and have the potential to improve patient health while decreasing costs. Though the upfront investment of such an intervention may give administrators pause, the longer-term potential for savings should prompt investigation into implementing a trial of a coordinated care program.

The data yielded in this research advances the knowledge about high utilizer patients by providing statistical evidence to a field that is still building its epidemiological foundation. While much attention is given to super-utilizers, the data provided about this population is often descriptive, anecdotal, or drawn from case studies and best practices. To our knowledge, this research is the only case-control study in a US public hospital that focuses on the demographic, social, and medical contributors to high utilization of inpatient health services. The study shows that utilization is not exclusively influenced by medical conditions, but instead is also impacted by social factors like insurance type and barriers to good health such as homelessness and substance use. The information in this study can help advance policy, such as federal or state funding for coordinated care efforts, programs, such as efforts aimed at stable housing, and further research exploring the root causes of high utilization of inpatient services. Hopefully, it will also become part of a greater body of evidence that drives health care reform efforts targeted at eliminating social and structural disparities that result in disproportionately poor health outcomes for marginalized members of society.

## VI. Works Cited


1. Weiss A, Barrett, M.L., C.A. Barrett M, Steiner, and C.A. Steiner, *Trends and Projections in Inpatient Hospital Costs and Utilization, 2003-2013: Statistical Brief #175 BTI - Healthcare Cost and Utilization Project (HCUP) Statistical Briefs.*
2. Sebelius, K., *The Affordable Care Act At Three: Paying for Quality Saves Healthcare Dollars*. 2013: Health Affairs Blog.
3. Zuckerman, S., Holahan, J. , *Despite Criticism, The Affordable Care Act Does Much to Contain Health Care Costs*. 2012, Urban Institute Health Policy Center.
4. Cosgrove, D.M., et al., *Ten Strategies To Lower Costs, Improve Quality, And Engage Patients: The View From Leading Health System CEOs.* Health Affairs, 2013. **32**(2): p. 321-327.
5. Cohen, S., *The Concentration of Health Care Expenditures and Related Expenses for Costly Medical Conditions, 2012*. 2014, Agency for Healthcare Research and Quality.
6. Cohen, S., *Statistical Brief #448: Differentials in the Concentration of Health Expenditures across Population Subgroups in the U.S., 2012*. 2014, Agency for Healthcare Research and Quality.
7. Stanton, M., *The High Concentration of US Health Care Expenditures*. 2006, Agency for Healthcare Research and Quality.
8. Steiner C., Barrett, M.L., et al., *Trends and Projections in Hospital Stays for Adults With Multiple Chronic Conditions, 2003-2014: Statistical Brief #183 BTI - Healthcare Cost and Utilization Project (HCUP) Statistical Briefs.*
9. Steiner, C.A. and B. Friedman, *Hospital utilization, costs, and mortality for adults with multiple chronic conditions, Nationwide Inpatient Sample, 2009.* (1545-1151 (Electronic)).
10. Moore B., Levit K., Elixhauser, A. *Costs for Hospital Stays in the United States, 2012: Statistical Brief #181 BTI - Healthcare Cost and Utilization Project (HCUP) Statistical Briefs.*
11. Weiss A., Elixhauser, A. *Overview of Hospital Stays in the United States, 2012: Statistical Brief #180 BTI - Healthcare Cost and Utilization Project (HCUP) Statistical Briefs.*
12. Hines A., Barrett, M.L., et al., *Conditions With the Largest Number of Adult Hospital Readmissions by Payer, 2011: Statistical Brief #172 BTI - Healthcare Cost and Utilization Project (HCUP) Statistical Briefs.*
13. Derose, K.P., J.S. Gresenz C., Ringel, J.S., *Understanding disparities in health care access--and reducing them--through a focus on public health.* (1544-5208 (Electronic)).
14. Andersen R., Newman, J.F, *Societal and individual determinants of medical care utilization in the United States.* (0160-1997 (Print)).
15. Andersen, R.M., *Revisiting the behavioral model and access to medical care: does it matter?* (0022-1465 (Print)).
16. Gawande, A., *The Hot Spotters*, in *The New Yorker*. 2011: New York, NY.
17. Mann, C., *Targeting Medicaid Super-Utilizers to Decrease Costs and Improve Quality*. 2013, Centers for Medicare & Medicaid Services.
18. Hasselman, D., *Super-Utilizer Summit: Common Themes from Innovative Complex Care Management Programs*. 2013, Center for Health Care Strategies.

19. Lopez-Gonzalez L, Pickens, G.T., et al., *Characteristics of Medicaid and Uninsured Hospitalizations, 2012: Statistical Brief #182 BTI - Healthcare Cost and Utilization Project (HCUP) Statistical Briefs.*
20. Jiang H., Barrett, M.L., Sheng, M., *Characteristics of Hospital Stays for Nonelderly Medicaid Super-Utilizers, 2012: Statistical Brief #184 BTI - Healthcare Cost and Utilization Project (HCUP) Statistical Briefs.*
21. Karaca, Z., Wong, H.S., Mutter,R.L., *Characteristics of Homeless and Non-Homeless Individuals Using Inpatient and Emergency Department Services, 2008: Statistical Brief #152 BTI - Healthcare Cost and Utilization Project (HCUP) Statistical Briefs.*
22. Creative Loafing Staff, *How Grady Memorial Hospital Skirted Death*, in *Creative Loafing*. 2013: Atlanta, GA.
23. Lee, C. *Grady Health System*. 2014 Dec. 24, 2014 Mar. 31, 2015]; Available from: http://www.georgiaencyclopedia.org/articles/science-medicine/grady-health-system.
24. Gamble, M. *50 Largest Public Hospitals in America*. Mar. 31, 2015].
25. Health, G., *Grady Health System Annual Report, 2013*. 2014: Atlanta, GA.
26. Dewan, S., Sack, K. , *A Safety-Net Hospital Falls into Financial Crisis*, in *New York Times*. 2008: New York, NY.
27. AJC Staff, *Health Care Overhaul's Impact on Georgia*, in *Atlanta Journal Constitution*. 2012: Atlanta, GA.
28. Frerichs, R., *Rapid Surveys: Simple Random Sampling*. 2008. p. 3-1 - 3-44.
29. *American Community Survey*. 2013, US Census Bureau
30. Harris, P.A., et al., *Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support.* (1532-0480 (Electronic)).
31. Hosmer, D., Lemeshow, S. , *Applied Logistic Regression*. 2005, Wiley & Sons.
32. Centers for Disease Control and Prevention. *Crude and Age-Adjusted Rate per 100 of Civilian, Noninstitutionalized Population with Diagnosed Diabetes, United States, 1980–2011*. 2014 Sep. 5, 2014 Mar. 31, 2015].
33. Centers for Disease Control and Prevention, *Recommendations to Prevent and Control Iron Deficiency in the United States*. 2008.
34. Kirby, S.E., et al., *Patient related factors in frequent readmissions: the influence of condition, access to services and patient choice.* BMC Health Services Research, 2010. **10**: p. 216-216.
35. Stuart, S., *Two Way Street: In Atlanta's Core, the AIDS Epidemic is Skyrocketing*. 2014, Georgia Public Broadcasting.
36. *AIDSVu*. [cited 2015 Mar. 31, 2015]; Available from: http://aidsvu.org/state/georgia/.
37. Rosella, L.C., et al., *High-cost health care users in Ontario, Canada: demographic, socio-economic, and health status characteristics.* BMC Health Services Research, 2014. **14**(1): p. 532.
38. Hebert, C., et al., *Diagnosis-specific readmission risk prediction using electronic health data: a retrospective cohort study.* BMC Medical Informatics and Decision Making, 2014. **14**(1): p. 65.
39. Hasan, O., et al., *Hospital readmission in general medicine patients: a prediction model.* (1525-1497 (Electronic)).
40. Bottle, A., Aylin, P., Majeed, A., *Identifying patients at high risk of emergency hospital admissions: a logistic regression analysis.* (0141-0768 (Print)).

41. Tricco, A.C., et al., *Effectiveness of quality improvement strategies for coordination of care to reduce use of health care services: a systematic review and meta-analysis.* (1488-2329 (Electronic)).
42. Emeche, U., *Is a Strategy Focused on Super-Utilizers Equal to the Task of Health Care System Transformation? Yes.* The Annals of Family Medicine, 2015. **13**(1): p. 6-7.
43. Bodenheimer, T., *Strategies to Reduce Costs and Improve Care for High-Utilizing Medicaid Patients: Reflections on Pioneering Programs*. 2013, Center for Healthcare Strategies.
44. *Super-utilizers get red carpet treatment*. [cited Mar. 31, 2015] Hospital Case Management. 2014. Available from: http://www.lexisnexis.com.proxy.library.emory.edu/lnacui2api/api/version1/getDocCui?lni=5BD8-X8C1-DXX0-P3DP&csi=365639&hl=t&hv=t&hnsd=f&hns=t&hgn=t&oc=00240&perma=true.
45. *New care model targets high-utilizing, complex patients, frees up emergency providers to focus on acute care concerns*. [cited Mar. 31, 2015] Emergency Department Management. 2013. Available from: http://www.lexisnexis.com.proxy.library.emory.edu/lnacui2api/api/version1/getDocCui?lni=59SY-G321-JBDY-03KN&csi=365614&hl=t&hv=t&hnsd=f&hns=t&hgn=t&oc=00240&perma=true

## VII. TABLES

Table 1. Patient social and demographic characteristics

| | Cases n = 247 | | Controls n = 247 | |
|---|---|---|---|---|
| **Characteristic** | **N** | **%** | **N** | **%** |
| Demographic Information | | | | |
| **Age, years mean (std. dev.)** | | 55.28(15.72) | | 56.09(15.62) |
| **Sex** | | | | |
| Male | 140 | 56.68 | 140 | 56.68 |
| Female | 107 | 43.32 | 107 | 43.32 |
| **Race*** | | | | |
| Black | 218 | 88.26 | 189 | 76.52 |
| White | 19 | 7.69 | 45 | 18.22 |
| Hispanic | 5 | 2.02 | 12 | 4.86 |
| Asian | 2 | 0.81 | 0 | 0 |
| Other | 2 | 0.81 | 1 | 0.4 |
| Not Specified | 1 | 0.4 | 0 | 0 |
| **Community-Level Median Household Income, dollars*** | | | | |
| 0 - 27,651 | 83 | 33.74 | 53 | 21.72 |
| 27, 652 - 39,421 | 69 | 28.05 | 58 | 23.77 |
| 39, 422 - 48,093 | 47 | 19.11 | 58 | 23.77 |
| 48,094 - 139, 543 | 47 | 19.11 | 75 | 30.74 |
| Insurance Information | | | | |
| **Insurance Status** | | | | |
| Uninsured | 67 | 27.13 | 91 | 36.84* |
| Insured | 180 | 72.87 | 156 | 63.16 |
| **Payers*** | | | | |
| Medicaid | 92 | 51.11 | 44 | 28.21* |
| Medicare | 62 | 34.44 | 32 | 20.51 |
| Medicare and Medicaid | 18 | 10 | 29 | 18.59 |
| Private/Other | 8 | 3.89 | 51 | 28.21 |
| Social History | | | | |
| **Alcohol Use** | | | | |
| Current Use | 108 | 43.72 | 94 | 38.06* |
| History of Use | 130 | 52.63 | 104 | 42.11* |
| Alcohol-Related Admission | 42 | 38.89 | 31 | 33.33 |
| **Tobacco Use** | | | | |
| Current Use | 104 | 42.11 | 85 | 34.41* |
| History of Use | 169 | 68.42 | 115 | 46.56* |
| **Substance Use** | | | | |
| Current Use | 70 | 28.34 | 24 | 9.72* |
| History of Use | 90 | 36.44 | 31 | 12.55* |
| **Homeless** | 47 | 19.03 | 11 | 4.45* |
| **Employed** | | | | |
| No | 175 | 70.85 | 94 | 38.21* |
| Yes | 9 | 3.64 | 23 | 9.35 |
| **Incarceration** | | | | |
| Currently Incarcerated | 16 | 6.48 | 8 | 3.24 |
| History of Incarceration | 30 | 12.15 | 13 | 5.26* |

*significant at alpha = 0.05

**Table 2. Patient diagnoses by disease category and organ system.**

| | Cases n = 247 | | Controls n = 247 | |
|---|---|---|---|---|
| **Diagnosis** | **N** | **%** | **N** | **%** |
| Neurological | 114 | 46.15 | 63 | 25.51* |
| Cardiac | 204 | 82.59 | 152 | 61.54* |
| Pulmonary | 116 | 46.96 | 47 | 19.03* |
| Gastro-Intestinal | 122 | 49.39 | 49 | 19.84* |
| Hematological | 151 | 61.13 | 42 | 17.00* |
| Infectious Disease | 64 | 25.91 | 21 | 8.50* |
| Renal | 98 | 39.68 | 33 | 13.36* |
| Gynecological/Urological | 51 | 20.65 | 32 | 12.96* |
| Musculoskeletal | 70 | 28.34 | 53 | 21.46 |
| Psychiatric | 90 | 36.44 | 45 | 18.22* |
| Endocrine | 110 | 44.53 | 67 | 27.13* |
| Trauma | 9 | 3.64 | 16 | 6.48 |
| Rheumatology/Nutritional Deficiencies/Other | 31 | 12.55 | 29 | 11.74 |
| **Weight Status** | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** |
| BMI | 27.06 | 8.04 | 27.76 | 7.11 |

*significant at alpha = 0.05

**Table 3. Health care utilization (ED visits, number of admissions, outpatient medications, length of stay, time to readmission, disposition) and mortality in cases and controls**

| | Cases n = 247 | | Controls n = 247 | |
|---|---|---|---|---|
| **Outcome** | **Mean (Std.Dev.)** | **Cumulative** | **Mean (Std.Dev.)** | **Cumulative** |
| **ED Visits, Year of High Use** | | | | |
| All Years | 8.11(7.36) | 2,003 | 1.74(1.58) | 431* |
| 2011 | 8.31(7.01) | 789 | 1.62(1.21) | 154* |
| 2012 | 6.88(5.33) | 585 | 1.89(2.01) | 164* |
| 2013 | 9.39(9.61) | 629 | 1.74(1.42) | 113* |
| **Number of Admissions, Year of High Use** | | | | |
| All Years | 4.55(2.01) | 1123 | 1.23(0.42) | 305* |
| 2011 | 4.79(2.11) | 321 | 1.26(0.44) | 82* |
| 2012 | 4.33(1.88) | 368 | 1.24(0.43) | 108* |
| 2013 | 4.57(2.05) | 434 | 1.21(0.41) | 115* |
| **Outpatient Medications, Year of High Use** | | | | |
| All Years | 18.39(7.50) | 4,543 | 6.28(4.97) | 1,550* |
| 2011 | 17.99(7.36) | 1,709 | 5.97(4.98) | 567* |
| 2012 | 18.26(7.05) | 1,552 | 6.46(4.51) | 562* |
| 2013 | 19.13(8.26) | 1,282 | 6.48(5.55) | 421* |
| | **Mean (Std.Dev.)** | **Median** | **Mean (Std.Dev.)** | **Median** |
| **Length of Stay (days)** | 5.9 (6.9) | 4 | 5.46(6.97) | 4 |
| **Time to Readmission (days)** | 46.5(53.4) | 26 | 59.87(66.22) | 30 |
| | **N** | **%** | **N** | **%** |
| **Disposition** | | | | |
| Nursing Home | 55 | 22.27 | 13 | 5.26* |
| Sub-Acute Rehab | 28 | 11.34 | 15 | 6.10* |
| Hospice | 23 | 9.31 | 5 | 2.83* |
| **Deceased** | | | | |
| No | 191 | 77.33 | 225 | 91.09 |
| Yes | 56 | 22.67 | 22 | 8.91* |

*significant at alpha = 0.05

**Table 4. Demographic, social, and medical contributions to high utilization of inpatient services at Grady Hospital.**

| | Group A | | Group B | | Group C | | Group D†‡ | |
|---|---|---|---|---|---|---|---|---|
| | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI |
| **Race** | | | | | | | | |
| Non-Black | 1 | | 1 | | 1 | | 1 | |
| Black | 1.927 | 1.162, 3.196 | 1.712 | 1.00, 2.931 | 1.818 | 1.015, 3.255 | 1.337 | 0.623, 2.869 |
| **Community Income Level (dollars)** | | | | | | | | |
| 0 - 27,651 | 2.155 | 1.286, 3.610 | 1.737 | 1.007, 2.998 | 1.93 | 1.086, 3.429 | 1.009 | 0.475, 2.145 |
| 27,652 - 39,421 | 1.64 | 0.976, 2.757 | 1.3 | 0.751, 2.251 | 1.373 | 0.765, 2.465 | 0.784 | 0.361, 1.704 |
| 39, 422 - 48,093 | 1.163 | 0.678, 1.996 | 1.157 | 0.648, 2.064 | 1.255 | 0.679, 2.318 | 0.728 | 0.321, 1.650 |
| 48, 094 - 139,543 | 1 | | 1 | | 1 | | 1 | |
| **Payer*** | | | | | | | | |
| Medicaid | | | 3.374 | 1.674, 6.801 | 2.38 | 1.134, 4.996 | 5.217 | 1.902, 14.305 |
| Medicare | | | 3.218 | 1.536, 6.742 | 3.454 | 1.606, 7.429 | 5.394 | 1.959, 14.854 |
| Medicare and Medicaid | | | 1 | | 1 | | 1 | |
| Private | | | 0.302 | 0.115, 0.795 | 0.344 | 0.127, 0.930 | 1.247 | 0.300, 5.180 |
| Self/None | | | 1.368 | 0.691, 2.708 | 1.22 | 0.594, 2.506 | 4.002 | 1.462, 10.958 |
| **History of Alcohol Use** | | | | | | | | |
| Yes | | | | | 0.789 | 0.497, 1.253 | 0.684 | 0.370, 1.266 |
| No | | | | | 1 | | 1 | |
| **History of Tobacco Use*** | | | | | | | | |
| Yes | | | | | 1.346 | 0.860, 2.105 | 1.833 | 1.003, 3.352 |
| No | | | | | 1 | | 1 | |
| **History of Substance Use*** | | | | | | | | |
| Yes | | | | | 2.797 | 1.609, 4.863 | 2.641 | 1.268, 5.501 |
| No | | | | | 1 | | 1 | |
| **Homelessness*** | | | | | | | | |
| Yes | | | | | 3.538 | 1.640, 7.635 | 2.906 | 1.122, 7.530 |
| No | | | | | 1 | | 1 | |

| Table 4 cont. | Group A | | Group B | | Group C | | Group D†‡ | |
|---|---|---|---|---|---|---|---|---|
| | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI |
| **History of Incarceration** | | | | | | | | |
| Yes | | | | | 1.174 | 0.518, 2.664 | 0.983 | 0.341, 2.832 |
| No | | | | | 1 | | 1 | |
| | | | | | | | | |
| **Medical History** | | | | | | | | |
| Neurological* | | | | | | | 2.682 | 1.505, 4.778 |
| Cardiac | | | | | | | 1.198 | 0.594, 2.417 |
| Pulmonary* | | | | | | | 3.332 | 1.868, 5.942 |
| Gastro-Intestinal* | | | | | | | 3.21 | 1.763, 5.468 |
| Hematological* | | | | | | | 5.947 | 3.245, 10.897 |
| Infectious Disease* | | | | | | | 2.86 | 1.397, 5.856 |
| Renal* | | | | | | | 3.424 | 1.765, 6.643 |
| Gynecological/Urological | | | | | | | 1.179 | 0.588, 2.367 |
| Muscular-Skeletal | | | | | | | 0.764 | 0.408, 1.431 |
| Psychiatric | | | | | | | 1.511 | 0.798, 2.860 |
| Endocrine* | | | | | | | 1.933 | 1.081, 3.457 |
| Rheumatology/Nutritional/Other | | | | | | | 0.499 | 0.224, 1.113 |
| Trauma | | | | | | | 0.758 | 0.220, 2.603 |
| BMI | | | | | | | 1.007 | 0.970, 1.045 |

*Retained in parsimonious model

†Group A adjusted for demographic characteristics, Group B added adjusting for insurance type, Group C added adjusting for social history, and Group D added adjusting for medical history

‡ R-square values for the adjusted models were as follows: 0.0437 (Group A), 0.1455 (Group B), 0.2154 (Group C), 0.433 (Group D)

**Table 5. Demographic, social, and medical contributors mortality of individuals admitted to inpatient services at Grady Hospital.**

| | HUP | | Group A | | Group B | | Group C | | Group D† | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI |
| **HUP Status** | 2.999 | 1.766, 5.092 | 3.223 | 1.848, 5.623 | 3.138 | 1.750, 5.627 | 3.607 | 1.967, 6.616 | 2.334 | 1.114, 4.893 |
| **Age (Years)** | | | 1.04 | 1.022, 1.058 | 1.049 | 1.027, 1.071 | 1.048 | 1.026, 1.072 | 1.049 | 1.023, 1.075 |
| **Sex** | | | | | | | | | | |
| Male | | | 1.034 | 0.607, 1.761 | 0.988 | 0.577, 1.691 | 0.939 | 0.530, 1.663 | 1.012 | 0.548, 1.902 |
| Female | | | 1 | | 1 | | 1 | | 1 | |
| **Race** | | | | | | | | | | |
| Non-Black | | | 1 | | 1 | | 1 | | 1 | |
| Black | | | 0.788 | 0.380, 1.636 | 0.828 | 0.395, 1.737 | 0.7 | 0.332, 1.504 | 0.552 | 0.241, 1.264 |
| **Community Income Level (dollars)** | | | | | | | | | | |
| 0 - 27,651 | | | 1.495 | 0.664, 3.367 | 1.47 | 0.647, 3.337 | 1.439 | 0.625, 3.311 | 1.216 | 0.497, 2.971 |
| 27,652 - 39,421 | | | 1.841 | 0.810, 4.185 | 1.839 | 0.805, 4.201 | 1.999 | 0.863, 4.632 | 1.638 | 0.662, 4.051 |
| 39, 422 - 48,093 | | | 2.285 | 0.999, 5.228 | 2.298 | 0.995, 5.305 | 2.321 | 0.991, 5.433 | 1.899 | 0.763, 4.728 |
| 48, 094 - 139,543 | | | 1 | | 1 | | 1 | | 1 | |
| **Payer** | | | | | | | | | | |
| Medicaid | | | | | 1.642 | 0.579, 4.653 | 1.694 | 0.588, 4.880 | 2.06 | 0.667, 6.358 |
| Medicare | | | | | 1.068 | 0.390, 2.925 | 1.141 | .410, 3.168 | 1.484 | 0.496, 4.434 |
| Medicare and Medicaid | | | | | 1 | | 1 | | 1 | |
| Private | | | | | 0.944 | 0.254, 3.505 | 1.033 | 0.273, 3.900 | 1.403 | 0.320, 6.154 |
| Self/None | | | | | 1.947 | 0.681, 5.562 | 1.823 | 0.624, 5.323 | 2.199 | 0.680, 7.112 |
| **History of Alcohol Use** | | | | | | | | | | |
| Yes | | | | | | | 2.027 | 1.056, 3.890 | 2.199 | 1.044, 4.272 |
| No | | | | | | | 1 | | 1 | |
| **History of Tobacco Use** | | | | | | | | | | |
| Yes | | | | | | | 1.106 | 0.613, 1.994 | 0.917 | 0.486, 1.731 |
| No | | | | | | | 1 | | 1 | |

| Table 5 cont. | HUP | | Group A | | Group B | | Group C | | Group D | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI | Odds Ratio | 95% CI |
| **History of Substance Use** | | | | | | | | | | |
| Yes | | | | | | | 0.598 | 0.292, 1.231 | 0.675 | 0.303, 1.505 |
| No | | | | | | | 1 | | 1 | |
| **Homelessness** | | | | | | | | | | |
| Yes | | | | | | | 0.649 | 0.252, 1.677 | 0.837 | 0.307, 2.281 |
| No | | | | | | | 1 | | 1 | |
| **History of Incarceration** | | | | | | | | | | |
| Yes | | | | | | | 0.485 | 0.130, 1.801 | 0.338 | 0.086, 1.326 |
| No | | | | | | | 1 | | 1 | |
| **Medical History** | | | | | | | | | | |
| Neurological | | | | | | | | | 0.806 | 0.435, 1.493 |
| Cardiac | | | | | | | | | 0.942 | .410, 2.165 |
| Pulmonary | | | | | | | | | 1.544 | 0.836, 2.854 |
| GI | | | | | | | | | 1.006 | 0.547, 1.852 |
| Hematological | | | | | | | | | 2.224 | 1.159, 4.268 |
| Infectious Disease | | | | | | | | | 1.351 | 0.654, 2.793 |
| Renal | | | | | | | | | 1.031 | 0.542, 1.964 |
| Gynecology-Urology | | | | | | | | | 1.497 | 0.769, 2.912 |
| Muscular-Skeletal | | | | | | | | | 0.605 | 0.300, 1.220 |
| Psychiatric | | | | | | | | | 0.594 | 0.290, 1.217 |
| Endocrine | | | | | | | | | 1.745 | 0.953, 3.195 |
| Rheumatology/Nutr./ Other | | | | | | | | | 1.097 | 0.477, 2.525 |
| Trauma | | | | | | | | | 0.52 | 0.062, 4.379 |
| BMI | | | | | | | | | 0.954 | 0.915, 0.996 |

†Group A adjusted for demographic characteristics, Group B added adjusting for insurance type, Group C added adjusting for social history, and Group D added adjusting for medical history
‡ R-square values for the adjusted models were as follows: 0.0517 (Group A), 0.0631 (Group B), 0.0744 (Group C), 0.1469 (Group D)

## VIII. APPENDICES

### Appendix A. Chart Abstraction Protocol

- Log into an outpatient environment in Epic (ex. Green/Purple/Orange Pod).
- Open the patient's record in RedCap.
- Each time you complete a form for a patient, make sure to mark it as "complete" in the drop-down box at the bottom, and don't forget to save it!
- Please use all lowercase letters for free text whenever possible.

1. Using the chart review button, type the MRN into the "patient lookup" box.
2. Fill in the Demographics form from information on the "patient snapshot" page.
    a. County and Race/ethnicity can be found by clicking on where it says "Demographics" above the patient's name and then clicking on "Clinical Information."
    b. If the patient is deceased, the date of death will be written in the same box as their name on the snapshot screen.
3. On the "Medical and Social Data" form, check the box for the year of high-utilization that you are analyzing.
4. In Epic, click on chart review → notes tab
5. Apply a filter by clicking filters → write in the dates that you want to look at (ex. 1/1/12 to 12/31/12) → click "category" → H&P
    a. You can save this filter to make it easier to apply later.
6. Sort by encounter date.
7. Fill in the number of admissions field based on the number of H&Ps.
8. Look through the H&Ps and fill in the diagnosis fields, as well as the checkboxes for mental health diagnoses and medical diagnoses.
    a. This is also the best place to find information about substance use, homelessness, employment, height, and weight, home O2, chronic Foley, etc.
    b. If the patient has a diagnosis that is one of the checkboxes, you do not need to repeat it in the free text boxes.
9. For the rest of the social and medical data, you should have it from the H&Ps, although you may need to look at discharge summaries as well to fill in the blanks.
10. Click on the "medications" tab and apply your date filter. Uncheck the box that says "current meds only." Click "generic drug name." Click on each medicine and see if there are any "AMB" prescriptions. Record the number of unique "AMB" prescriptions within the year.
    a. Supplies do not count (i.e. insulin syringes, lancets, etc.)
    b. Different formulations of the same medicine count, ex. Lantus and aspart would count as two medications.
11. Click on the imaging tab and apply the date filter you used above.
12. Click study status → final → sort by name
13. Fill in the type and number of imaging studies that the patient had during the year you are analyzing.
    a. Please note that IR procedures will have multiple procedures listed for the same date, please only count each date once.

   b. TTE/TEE count as ultrasounds.
   c. Heart catheterizations may be listed here but they should be recorded under surgeries.
14. Click the "surgeries" tab to see if the patient had any surgeries.
   a. Look in the notes tab as well under "procedures" and for any "op notes" for any other surgeries that may not be recorded elsewhere.
   b. Later, when you are reviewing the discharge summaries, keep your eyes peeled for any procedures that may be documented in the d/c summary but not elsewhere.
15. Look at the social work notes for documentation of insurance status.
16. For PCP, click on "encounters" and apply your date filter.
   a. Look under department specialty for internal medicine, family medicine, infectious disease (if they go to Ponce clinic), and geriatrics.
   b. Count the number of appointments or office visits (do NOT count encounters marked "orders only" or "telephone" or where an appointment was canceled because of the provider) and record both the total visits and the number of missed appointments.
   c. If they have never been to a PCP appointment, look to see if they have ever been seen as an outpatient.
   d. At this point, I also look to see if there are any outpatient mental health notes and if so, how many visits the patient had.
17. For number of ED visits, go back to the notes tab and uncheck H&P. Scroll down and click "ED provider notes." There is at least one ED provider note per ED visit (if the patient was actually seen), so you can just count the number of separate visits under this screen.
18. For mental health referral, there are three places to look for this:
   a. Look under the "referrals" tab
   b. Look and see if they have seen a mental health provider as an outpatient during the year you are analyzing.
   c. Look and see if a mental health referral is documented in a discharge summary.
19. Fill in other data like chronic Foley, trach, and discharge to NH/SAR/Hospice as appropriate.
20. From each discharge summary, record the date of admission, date of discharge, if the patient left AMA or not, their chief complaint, reason for admission, and what service they were admitted to (medicine, ICU, surgery, psych, etc.).
   a. Make sure the number of discharge summaries correlates with the number of admissions your listed on the previous form.
21. Click complete and save form.

**Appendix B. Classification of patient diagnoses by organ system/disease category.**

| Organ System/Disease Category | Diagnosis |
|---|---|
| Neurological | Autism, Bell's palsy, blindness, benign paroxysmal positional vertigo, brain mass, carpal tunnel, cerebral aneurysm, cervical myelopathy, cervical spinal stenosis, cervical spine fracture, cns vasculitis, cognitive impairment, craniotomy<br>cerebrovascular accident, deafness, dementia, developmental delay, empty sella syndrome, frontal lobe dementia, hydrocephalus, intracerebral hemorrhage, intracranial hemorrhage, memory loss, meningioma, migraines, multiple sclerosis, neurofibroma, neuropathy, normal pressure hydrocephalus, paraplegia, Parkinson's disease, peripheral neuropathy, post-herpetic neuralgia, pseudoseizures, quareparesis, restless leg syndrome, sciatica, seizures, spastic quadriplegia, subarachnoid hemorrhage, subdural hematoma, transient ischemic accident, traumatic brain injury, trigeminal neuralgia, vascular dementia, vertigo |
| Cardiology | Abdominal aortic aneurysm, alcoholic cardiomyopathy, afib with RVR, aicd, aicd placement, angina, aortic aneurysm, aortic dissection, aortic insufficiency, aortic valve replacement, atrial fibrillation, atrial septal defect, atrial tachycardia, atrioventricular dissociation, bradycardia, coronary artery bypass graft, coronary artery disease, cardiac arrest, cardiac cirrhosis, carotid artery occlusion, carotid atherosclerosis, carotid stenosis, chest pain, congestive heart failure, cor pulmonale, hypertensive emergency, hyperlipidemia, hypertension, hypertrophic cardiomyopathy, ischemic cardiomyopathy<br>LAD, left bundle branch block, left vventicular thrombus, left venticular hypertrophy, myocardial infarction, mitral valve prolapse, mitral valve replacement, mural thrombus, non-ST elevation MI, orthostatic hypotension, pacemaker, peripheral artery disease, PEA arrest, pericardial effusion, pericarditis, peripheral vascular disease, postural orthostatic tachycardia syndrome, sick sinus syndrome, supraventricular tachycardia, syncope, valvular heart disease, venous insufficiency, venous stasis |
| Pulmonary | Asthma, bronchitis, bronchogenic carcinoma, chronic respiratory failure, chronic obstructive pulmonary disease, empyema, hemoptysis, hemothorax, interstitial lung disease, lung cancer, lung mass, lung metastases, malignant pleural effusion, obesity hypoventilation syndrome, |

| | |
|---|---|
| | obstructive sleep apnea, pulmonary arterial hypertension, periapical abscess, pleural effusion pneumonia, pneumothorax, pulmonary emboli, pulmonary hypertension, pulmonary nodules, restrictive lung disease, sarcoidosis, tracheal stenosis, tracheocutaneous fistula, tuberculosis |
| Gastrointestinal | Abdominal abscess, achalasia, alcoholic hepatitis, antral gastritis, appendicitis, ascites, atrophic gastritis, areteriovenous malformation, clostridium difficile infection, cecal perforation, cholecystectomy, chronic diarrhea, chronic pancreatitis, cirrhosis, colectomy, colon cancer, colon polyp, colon resection, colostomy, colovesicular fistula, common bile duct obstruction, constipation, Crohn's disease, diarrhea, distal pancreatectomy, diverticulitis, diverticulosis, duodenal ulcer, duodenitis, dysphagia, end ileostomy, erosive esophagitis, end-stage liver disease, esophageal dysmotility, esophageal stricture, esophageal ulcer, esophageal varices, esophagitis, gasroparesis, gastric adenocarcinoma, gastritis, gastroenteritis, gastroesophageal reflux disease, GI bleed, H. pylori, Hepatitis B virus, Hepatitis C virus, hematemesis, hemoperitoneum, hemorrhoids, hepatic encephalopathy, hepatic steatosis, hepatocellular carcinoma<br>hernia, ileostomy, inguinal hernia, intestinal obstruction, lower GI bleed, nonalcoholic, steatohepatitis, ostomy, pancreatitis, partial hepatectomy, peritonitis, portal hypertension, peptic ulcer disease, rectovaginal fistula, retroperitoneal abscess, spontaneous bacterial peritonitis, sigmoid adenocarcinoma, small bowel obstruction, upper GI bleed, variceal bleed, varices, ventral hernia, ventral hernia repair, gastroparesis |
| Hematological | Acute lymphocytic leukemia, acute myelogenous leukemia, anemia, autoimmune hemolytic anemia, basal cell carcinoma, breast cancer, breast mass, coagulopathy<br>deep venous thrombosis, diffuse large b-cell lymphoma, fibrous histiocytoma, glioblastoma multiforme, cancer of unknown primary, heparin-induced thrombocytopenia, idiopathic thrombocytopenic purpura, laryngeal carcinoma, lymphoma, metastatic breast cancer, monoclonal gammopathy of undetermined significance, monoclonal paraproteinemia<br>multiple myeloma, myelodysplastic syndrome, myelofibrosis, nasopharyngeal cancer, neutropenia, |

| | |
|---|---|
| | osteosarcoma, pancytopenia, polycythemia, Protein S deficiency, sickle cell anemia, sickle cell trait, splenectomy, splenic infarct, squamous cell carcinoma of the tongue, thrombocytopenia, thrombocytosis, thromboembolic disease, tonsilar squamous cell carcinoma, unknown GU cancer |
| Infectious Disease | HIV/AIDS, abscesses, candidiasis, cellulitis, chronic osteomyelitis, cytomegalovirus retinitis, cns toxoplasmosis, cryptococcal meningitis, dental abscess, diabetic foot ulcer, disseminated mycobacterium avium infection, dry gangrene , endocarditis, g6pd deficiency, gangrene of finger, gluteal abscess, gonococal bacterial endocarditis, herpes zoster meningitis, hidradenitis suppurativa, HIV retinopathy, HIV-associated nephropathy, HSV laryngitis, Kaposi's sarcoma, latent tuberculosis infection, Ludwig's angina, lumbar spinal stenosis, lymphadenopathy, m. kansasii infection, mycobacterium avium, meningitis MRSA bacteremia, MRSA pneumonia, neurosyphilis, nocardia pneumonia, osteomyelitis, PCP pneumonia, perianal abscess, periorbital abscess, positive PPD, postoperative infection, progressive multifocal leukoencephalopathy, recurrent severe sepsis, recurrent UTI, rheumatic fever, sacral abscesses, scabies, septic arthrtitis, shingles, sinusitis, thrush, UTI, vertebral osteomyelitis, wound infection |
| Renal | acute interstitial nephritis, chronic hydroureter, chronic kidney disease, congenital solitary kidney, contrast-induced nephropathy, end-stage renal disease, hydronephrosis, hyperphosphatemia, hypokalemia, hyponatremia, nephrectomy, nephrolithiasis, nephrostomy tube, nephrotic syndrome, pyelonephritis, renal artery stent, renal cell carcinoma, renal tubular acidosis type 4, staghorn calculi |
| Gynecology/Urology | BPH, cervical cancer, chlamydia, dysmenorrhea, emphysematous cystitis, endometrial cancer, erectile dysfunction, fibroids, genital herpes, gonorrhea, hypospadias, incontinence, menorrhagia, metastatic vaginal, neurogenic bladder, obstructive uropathy, ovarian cancer, ovarian cyst, ovarian torsion, pelvic floor insufficiency, pelvic inflammatory disease, dysfunctional uterine bleeding, preeclampsia, priapism, prostate cancer, syphilis, testicular cancer, ureteral stent, uterine cancer, uterine fibroids, vaginal cancer, vaginitis |

| | |
|---|---|
| Musculoskeletal | ankle fracture, ankle pain, arthritis, avascular necrosis, back pain, c3-c6 laminectomy, cervical stenosis, chronic cauda equine, chronic leg pain, chronic pain, chronic wound, clavicle fracture, degenerative disc disease, degenerative joint disease, decubitus ulcer, elbow fracture, elevated CPK, facial fracture, femoral fracture, fibromyalgia, gout, hip fracture, hip replacement, laminectomy, leg amputation, leg fracture, leg ulcers, lumbar spine fracture, mandible fracture, multiple fractures, myopathy, neck hematoma neck pain, neuropathic pain, osteoarthritis, osteopenia, osteoporosis, paresthesias, pathologic fracture, rotator cuff tear, spinal cord compression, spinal stenosis, t12 fracture, tibial fracture |
| Psychiatric | Bipolar disorder, anxiety, depression, drug overdose, alcohol abuse, hypomania, opioid dependence, personality disorder, psychosis, PTSD, schizoaffective disorder, schizophrenia, suicidal ideation, suicide attempt |
| Endocrine | Diabetes mellitus, adrenal insufficiency, diabetic neuropathy, diabetic ketoacidosis, gestational diabetes, hyperglycemic hyperosmolar state, hyperparathyroisim, hyperthyroidism, hypothyroidism, obesity, panhypopituitarism, primary hyperaldosteronism, thyroid nodule, thyroidectomy, toxic multinodular goiter |
| Trauma | Motor vehicle collision, burn injury, compartment syndrome, electrocution, gunshot wound, sexual assault victim, head trauma, stab wound |
| Rheumatology/Nutritional/Other | Allergic rhinitis, angioedema, axillary swelling, B12 deficiency, blindness, cataracts, chiari malformation, domestic abuse, eczema, eye enucleation, failure to thrive, fistula, glaucoma, hearing impairment, hypercalcemia, hypoalbuminemia, IgG-4 deficiency, insomnia, systemic lupus erythematosus, malnutrition, polymyositis, presbycusis, primary polydipsia, rheumatoid arthritis, scleroderma, seasonal allergies, serotonin syndrome, stem cell transplant, vitamin D deficiency, vocal cord dysfunction |