EVALUATING RISK FOR PSYCHIATRIC RE-HOSPITALIZATION

A RECURRENT EVENT HISTORY ANALYSIS

By

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Abstract

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Between 1960 and 2010, the number of psychiatric treatment beds in the United States dropped ten-fold – from 300 to 30 beds per 100,000 persons. The vision for this planned deinstitutionalization was to replace substandard institutional care with community based treatment. In reality, the community care system has failed to meet the needs of many patients with serious mental illness. Approximately one in five patients hospitalized with schizophrenia, bipolar disorder or major depression disorder are re-hospitalized within 30 days. Furthermore, many high-risk patients in this population are recurrently hospitalized and may cycle between emergency departments, jail and homelessness.

This study addresses two questions related to recurrent psychiatric hospitalizations: 1) how do risk factors for re-hospitalization vary between the initial and subsequent hospital episodes, and 2) is length of inpatient treatment related to a reduced risk of re-hospitalization in latter episodes? This retrospective, observational cohort study utilizes administrative records from nineteen community hospitals in Washington State to follow patients for up to two years post-discharge. The study cohort of 27,858 adult patients were first hospitalized between 2012 and 2015. A repeated-event Cox proportional hazard model was used to test for factors

associated with the first, second and third psychiatric re-hospitalization.

This analysis differs from existing studies on this topic in two important ways. First, patients in the study population have no psychiatric hospitalizations within the last three years. Second, risk for concurrent psychiatric re-hospitalizations are examined, as opposed to a single event. This longitudinal approach permits an assessment of the initiation and progression of re-hospitalization risk. The findings illustrate a set of demographic, clinical and financial factors that are strongly predictive of re-hospitalization following an initial psychiatric hospitalization (c=0.81). In latter episodes, results indicate that length of inpatient treatment has a small, but significant association with reduced re-hospitalization risk.

Currently, there are no standardized, validated instruments in the United States to assess for psychiatric re-hospitalization risk. This research lays the groundwork for the early identification of high risk patients and eventual targeting of treatment resources to prevent the ongoing cycle of repeated psychiatric hospitalizations.

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Dedication

For persons seeking parity in mental health treatment

<center>**Chapter One**</center>

<center>**Introduction**</center>

Over fifty years ago, a fundamental shift in the care and treatment of persons with psychiatric conditions – such as schizophrenia, bipolar disorder, and major depression - took place throughout the United States. This policy, referred to as deinstitutionalization, was designed to move patients out of long-term state psychiatric hospitals and into independent living arrangements (Chow & Priebe, 2013). While the patient population in state psychiatric institutions declined by 90 percent during this time, this shift did not occur without notable side-effects. The period of deinstitutionalization marks a series of unfulfilled expectations, insufficient public treatment funding, and an unavoidable reality that many formerly institutionalized adults did not prosper in the community, but instead cycled between homelessness, jails, and repeated short-term community hospital admissions (Geller, Guzofski, & Lauterbach, 2009). A growing emphasis on community mental health care following deinstitutionalization did not fully address the acute-care needs of the most difficult-to-reach patients. This chapter chronicles the inadequate and diminished response of the mental health system following this era and argues that improved efforts are needed to identify and serve the resulting psychiatric patient population with recurrent admissions to community hospitals.

The move toward deinstitutionalization originated in the mid-part of the twentieth century following the exposure of overcrowding and deplorable conditions in state-run institutions. The publication of several investigative reports and novels at this time drew attention to the deterioration within these mental hospitals and resulted in growing calls for reform (Hunter, 1999). The call for shifting care to the community grew even louder following

<center>1</center>

the development and release of chlorpromazine, the first psychiatric medication approved to help individuals manage positive symptoms of psychosis without heavy sedative effects. Chlorpromazine, also called Thorazine, was considered a breakthrough medication and became widely used during the late 1950s and 1960s. Certain adverse side effects, such as a loss of muscular control, called tardive dyskinesia, led to a diminished use of the drug over time (Ban, 2007). Nevertheless, the advent of chlorpromazine hastened the depopulation of mental institutions and began the growing use of pharmacotherapy as a primary treatment for psychiatric illnesses.

Landmark political and legal decisions also spurred the move toward deinstitutionalization in the United States. The Community Mental Health Act (CMHA), passed in 1963, was intended to replace institutional care with community-based mental health treatment programs. Through the CMHA, Congress provided construction grants and seed money for communities to build outpatient mental health clinics. In 1965, the federal government also established two new social insurance programs – Medicaid for low-income families and Medicare for elderly and (later) disabled individuals. In an effort to foster the growth of community mental health care, Congress prohibited Medicaid funds from being used to reimburse stays in psychiatric hospitals with more than sixteen beds. In subsequent years, states responded to these new financial incentives by discharging a greater number of psychiatric patients from state-funded institutions and encouraging community-based care (Salinsky & Loftis, 2007). The United State Supreme Court also affirmed the civil liberties of psychiatric patients and limited the scope of institutional care in O'Connor v. Donaldson (1975), holding that persons could not be involuntarily committed to psychiatric treatment if they did not pose a

danger to self or others. Consequently, states narrowed the duration and legal rationale for institutional confinement related to psychiatric illness.

The accumulation of legal, social, clinical and economic developments that occurred during this period resulted in a steep decline in the availability of inpatient psychiatric care. At the peak in 1955, there were over 559,000 public mental health hospital beds in the United States, or 339 per 100,000 persons (Lamb & Weinberger, 2005). As Figure 1 shows, by 2000, there were 128,600 total beds (public or private) remaining, for a total rate of 45.7 psychiatric beds per 100,000 persons. By 2010, the latest year for which data are available, there were fewer than 95,000 psychiatric beds available in the United States, or 30.6 beds per 100,000 persons.

As Figure 1 also shows, by 2010 there were nearly twice as many psychiatric beds available in community and private hospitals (61,002) compared to state mental health hospitals (33,348). The ongoing contraction of state-run psychiatric beds has left these public institutions primarily focused on sexually dangerous persons, psychiatric patients with functional incapacities, and forensic patients committed by criminal courts as not yet competent to stand trial or guilty by reason of insanity (Fisher, Geller, & Pandiani, 2009). Persons experiencing acute psychiatric crises that did not fit in these categories were required to visit emergency departments or inpatient psychiatric units within community hospitals.

Statement of the Problem

Today, advances in psychopharmacology and psychotherapy have improved the likelihood that persons can effectively navigate symptoms and distress associated with psychiatric conditions. However, inpatient psychiatric hospitals will always be a necessary part of the care continuum. Undiagnosed and poorly managed cases, medication problems, and psychiatric emergencies require hospital care for stabilization and recovery. Yet, the psychiatric

hospital system – including government and non-government hospitals - has remained sorely

neglected in the United States, as noted by Sharfsten and Dickerson (2009):

> What has emerged today is evidence of psychiatric bed shortages, increased use of
>
> emergency departments for acute psychiatric crises, and shortfalls in the funding of
>
> community-based services. This has led to a public health crisis for mentally ill people
>
> who have become homeless or who are incarcerated in the nation's jails and prisons. (p.
>
> 685)
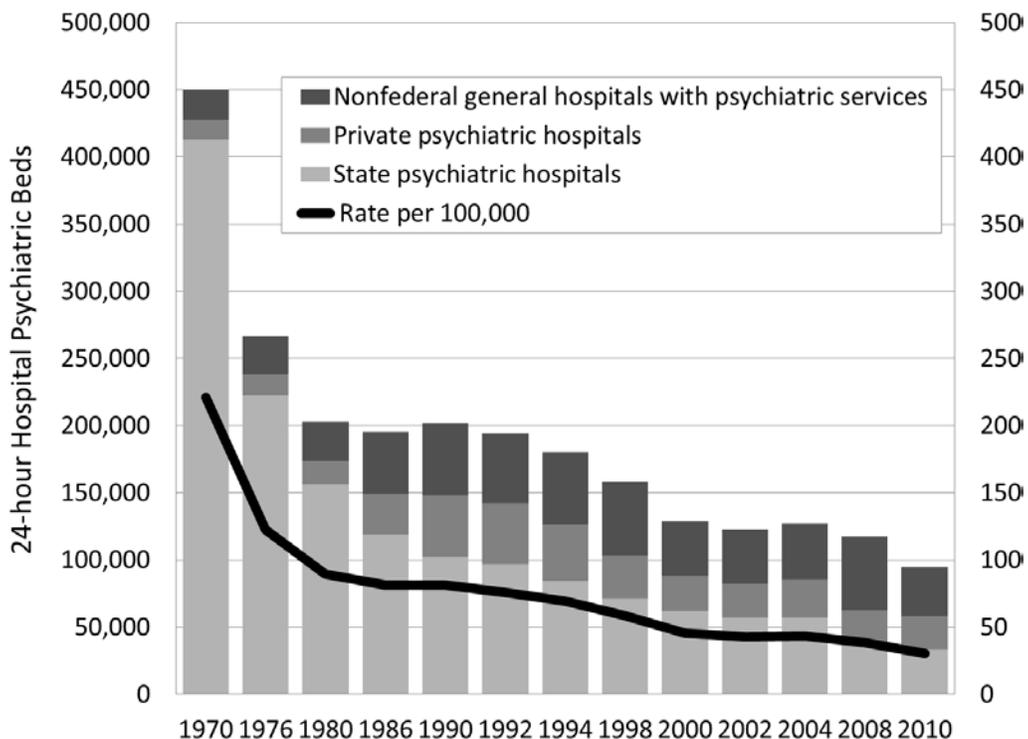
Figure 1. Psychiatric Bed Capacity 1970-2010.
Adapted from "Mental Health, United States 2004," by R. W. Manderscheid, and J. T. Berry, 2006, Rockville, MD: Substance Abuse and Mental Health Services Administration, table 19.2, p. 203 and "Health, United States, 2011," A. Bernstein, L. T. Bilheimer, and D. M Makuc, 2012, Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics, table 117, p 358 and "Behavioral Health, United States, 2012," 2013, Rockville, MD: Substance Abuse and Mental Health Services Administration. table 99, p. 207.

For patients with severe and chronic mental illnesses, the American mental health system has largely substituted extended psychiatric care for a series of recurrent short-term hospitalizations. A systemic problem arises when these brief hospital stays fail to adequately stabilize symptoms or support prolonged recovery, leaving patients vulnerable to a cycle of rapid readmissions, homelessness or jail.

This study aims to elucidate those factors related to subsequent hospital returns and ascertain if shorter hospital stays that may save money in the short-term leave the patient more vulnerable and actually place them at higher risk of repeated psychiatric hospitalizations in the long term. The decades-long transition from an admittedly abysmal system of psychiatric institutionalization to an emphasis on community based mental health care can leave the impression that recovery-oriented reform should not include any discussion of inpatient care practices. However, as Glick, Sharfstein and Schwartz (2011) claim, "It is not paradoxical to note that although a diminished role for institutional care is consistent with recovery, ultrashort hospitalizations may diminish opportunities for a sustained recovery" (p. 206). This study will uniquely address this problem from a chronological standpoint, by evaluating the changing role of risk factors and treatment intensity following the first, second, and subsequent psychiatric hospitalizations.

Research Questions

The principal intent of this research is to develop an informative and methodologically sound approach to identifying recurrent hospitalization risk among adults with psychiatric conditions. The rationale behind this approach contends that treatment models can be better tested and employed if it is possible to make an early determination about which hospitalized

patients may be prone to failure. This contention requires a careful testing of the primary research hypotheses outlined for this study:

H_0: Risk factors for subsequent psychiatric re-hospitalization are not associated with the timing and sequence of hospital events.

H_1: Risk factors for psychiatric re-hospitalization may vary between the initial and each subsequent hospital event.

A secondary goal of this research study is to assess the relationship between treatment time and re-hospitalization risk based on observed history of psychiatric hospitalizations. The notion that patients admitted to a psychiatric hospital are not a homogeneous group forms the basis for this approach and informs the secondary research hypotheses.

H_0: The effect of inpatient length of stay is invariant across psychiatric hospitalization episodes.

H_1: Length of stay is not associated with re-hospitalization outcomes for patients experiencing an initial psychiatric hospitalization.

H_2: Increased length of stay is associated with reduced re-hospitalization risk beyond the first admission.

These research hypotheses explore the prospect that psychiatric hospitals serve different types of patients – those that may require a one-time inpatient respite to safely resolve a mental health crisis, and those with multiple admissions due to persistent difficulties managing symptoms of psychiatric distress and maintaining a course of treatment.

Context

The existing research base has thus far provided little evidence about how to identify or respond to patients with repeated hospitalizations. The systematic review presented in Chapter 2 shows that, with a few exceptions, current studies on psychiatric re-hospitalization focus on a relatively narrow time period. These short-term studies have been unable to produce clear, consistent indicators of re-hospitalization risk. Furthermore, many available studies consider the hospitalization event as distinct from the entire process of recovery experienced by a patient. In recent decades, the recovery movement has shaped mental health policy and research in the United States by emphasizing the ongoing role of patient autonomy, the use of peer support, the importance of dignity, and the provision of social supports (Davidson, O'Connell, Tondora, Styron, & Kangas, 2006; Frese, Stanley, Kress, & Vogel-Scibilia, 2001). Recovery-oriented research, however, has largely centered around outpatient care practices and often overlooked the importance of inpatient treatment (Kidd, McKenzie, & Virdee, 2014; Wright, Rowley, Waring, Chopra, & Gregoriou, 2015). The objective of this current study is to provide a longitudinal assessment of the potential for recovery following psychiatric hospitalization, a critical point of engagement in a recovery-oriented system.

Clearly, repeated psychiatric hospitalizations signal a breakdown in a patient's symptom management and indicate that the treatment and supports necessary to achieve recovery have not been adequate to stabilize the patient's condition. The basis of this research is to develop a framework for the timing, targeting, and extent of treatment intervention. The difficulty of this task stems from the complexity of patient population and the likelihood that the signs of relapse may occur outside the hospital setting, as noted by Prins (2011):

Indeed, the most important takeaway from this debate may be a fact that is often

overlooked by policymakers working to address this issue: people with mental illnesses

are not a homogeneous population. Increased access to acute and intermediate psychiatric

beds may, in fact, be necessary for a small, but high-risk, high-cost group of people with

severe mental illnesses that cycle through emergency rooms and the criminal justice

system without obtaining the treatment they need (p 720).

A broad-based interdisciplinary approach is needed to determine which psychiatric patients may

have the greatest difficulty with transitions following discharge (Friedman, 2015). While in the

hospital, nurses and psychiatric clinicians are involved with patient care. But following

discharge, the individual may interact with community mental health, social welfare, and

criminal justice systems. Detail about these interactions may be particularly informative in

determining which patients may be prone to returning to the hospital and may benefit from

extended inpatient care.

Significance of Study

This study on psychiatric re-hospitalizations has important implications for clinicians,

family members, administrators and policymakers struggling to develop a coordinated and

targeted system of care for patients with persistent treatment difficulties. In Washington State,

this issue carries added weight as a result of an August 2014 State Supreme Court decision that

involved the overuse of psychiatric boarding in the state. Boarding refers to the holding of

psychiatric patients in emergency departments for an extended period because treatment beds are

unavailable (Bender, Pande, & Ludwig, 2008; Nolan, Fee, Cooper, Rankin, & Blegen, 2015).

The court ruled that patients facing a mental health commitment, as a result of dangerousness to

self or others, could not be detained without appropriate psychiatric evaluation and treatment.

This case called attention to the insufficient mental health services in the state and recognized a patient's right to proper assessment, care and support while hospitalized. While the number of psychiatric beds in Washington increased by nearly 160 in the year following this decision, it remains unclear if these changes will ultimately reduce utilization and improve patient outcomes (Bloom, 2015).

Mental health related hospitalizations are a growing concern at the national level as well. A recent analysis of the National Health Expenditures Accounts (NHEA) found that mental disorders accounted for the highest level of spending of any health condition, with annual expenditures exceeding $200 billion in 2013. Institutionalized or hospitalized patients made up nearly half of the total spending on mental health conditions (Roehrig, 2016). Despite increased spending on treatment, outcomes following a mental health-related hospitalization remain poor. In 2013, patients admitted with a primary diagnosis of schizophrenia or other psychotic disorders had the second highest readmission rate among all conditions, with 23% returning within 30-days. Patients with a primary mood disorder diagnosis had a 30-day readmission rate of 15%, and the fourth highest number of patients (n=114,385) with a 30-day readmission (Fingar & Washington, 2015).

Federal efforts to address preventable readmissions were set forth with the implementation of the Hospital Readmissions Reduction Program (HRRP) in 2013. The HRRP was included as a part of large scale healthcare reform enacted under the Patient Protection and Affordable Care Act (ACA) ("Patient Protection and Affordable Care Act," 2010). This program created a financial penalty for hospitals with excessive 30-day readmission rates. While the rates

are calculated for Medicare patients with selected medical conditions,[1] the overall goal of the

HRRP remains to reduce healthcare spending and improve care quality, particularly for costly

conditions with a high volume of admissions (Berenson, Paulus, & Kalman, 2012). It is worth

noting that schizophrenia and mood disorders represent the two conditions with the highest

number of 30-day readmissions among adult Medicaid patients (Hines, Barrett, Jiang, & Steiner,

2006). A greater understanding of the reasons behind these events is necessary to reduce the

personal and public costs associated with repeated psychiatric hospitalizations.

Study Limitations

This planned research will examine psychiatric re-hospitalization using an observational,

longitudinal study design – an approach that has rarely been incorporated in existing studies of

this topic. While there may be potential benefits from looking at the progression of psychiatric

hospital events, there are also several limitations to the proposed design. First, the study will be

based on re-hospitalizations that occur solely within Washington State; patients experiencing a

later hospitalization that occurs out-of-state will be lost to follow-up. In addition, the state-

specific findings may not be generalizable to psychiatric patient populations in other states.

Another limitation stems from the reliance on administrative records for this proposed

dissertation research. The use of hospital discharge records and other statewide data systems

permits the examination of a large population of patients over time. However, descriptive details

about situations surrounding a hospitalization are excluded from analyses of secondary data.

Interviews with patients have found that stressful events, such as conflict with a family member

or partner, financial difficulties, or employment problems are often linked to a re-hospitalization

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[1] Conditions include acute myocardial infarction (AMI), congestive heart failure, pneumonia, chronic obstructive
pulmonary disease (COPD), and hip/knee replacement.

(Doerfler, Moran, & Hannigan, 2010; Mgutshini, 2010). This finding may reflect the stress-sensitization, or 'kindling' theory of psychiatric episode recurrence. Under this theory, the ability of certain individuals to handle stress declines over time, such that with each successive episode, increasingly minor stressors may precipitate symptom onset (Harkness, Hayden, & Lopez-Duran, 2015; Monroe, 2005; Post, 2007). While this study may not measure the level or type of psychosocial stressors associated with an acute hospitalization, the longitudinal analysis of other cumulative risk factors provides a valuable compliment to qualitative studies in this area.

Summary

The system of mental health treatment in the United States has reached a point of divergence, with an increased emphasis on community-based services occurring alongside a steady erosion of treatment beds and troublesome outcomes for psychiatric inpatients. The re-hospitalization rate for patients with a mental-health related diagnoses stands among the highest of all conditions. Many of these patients with persistent difficulties continue to cycle between hospitals, the streets and jail. The costly toll of this problem and obvious deficiencies behind our current response recently led some prominent ethicists to question whether it was time to "bring back the asylum" (Sisti, Segal, & Emanuel, 2015). While the provocative title of this editorial aroused debate, the authors do not advocate for a return to the decrepit institutions of the past. Rather, they proposed re-thinking the role of long-term psychiatric care and developing integrated, patient-centered approaches. To make this step, more knowledge is needed about the relationship between patient characteristics and hospitalization outcomes. This dissertation research includes the review of current literature on psychiatric re-hospitalizations and outlines a method for adding to this research with a long-term, comprehensive study of hospitalization episodes.

Chapter Two

Review of Literature

Introduction

Since the era of deinstitutionalization, scholars have studied the defining characteristics and treatment trajectory of psychiatric patients that cycle through local hospitals. Re-hospitalization signifies a potential setback in the treatment and recovery process and is problematic for several reasons. From an economic perspective, recurrent psychiatric hospital stays are costly for providers, patients and their families. Average patient costs for a mental-health related hospitalization increased in inflation-adjusted dollars from \$5,800 in 2003 to \$6,600 in 2013 (Weiss, Barrett, & Steiner, 2014). In 2006, total costs for community-based inpatient psychiatric care exceeded \$10 billion in the United States (Stensland, Watson, & Grazier, 2012). The subgroup of patients with multiple hospitalizations contributes disproportionately to this cost. A study that followed patients with psychiatric hospitalizations over a seven-year period found that while 25% of patients had multiple admissions, these patients accounted for 80% of all bed days (Hudson, 2005).

The human cost associated with recurrent psychiatric admissions far exceeds observed treatment costs. Doerfler and Hannigan (2010) examined case notes and interviewed recurrent patients, finding that approximately two-thirds of these patients experienced a psychiatric hospitalization as a result of suicidal ideation. Those with recurrent re-hospitalizations also have significantly higher adjusted odds of exhibiting disruptive or dangerous behaviors (Sullivan, Young, & Morgenstern, 1997). The array of persistent and chronic difficulties experienced by

persons with repeated hospitalizations draw attention to the systemic failure of the mental health services system to adequately address the treatment requirements of this high-need population.

The resource demands that occur as a result of psychiatric re-hospitalizations raise important questions about the effectiveness of hospital care patients receive. Early re-hospitalization is becoming an increasingly important indicator for the quality of inpatient hospital care for medical conditions (Jha, 2015; Ness & Kramer, 2013). Yet, in the mental health care system, linking care quality to re-hospitalization outcomes may be more problematic. Based on a systematic review of studies completed between 1991 and 2004, Gerolamo (2004) concluded that there was a "lack of empirical evidence substantiating the relationship between readmission to quality hospital characteristics and care" (p. 210). However, the relationship between the quality of inpatient care and re-hospitalization may also depend on patient symptom severity, socioeconomic status and duration of follow-up time (Craig, Fennig, Tanenberg-Karant, & Bromet, 2000). Psychiatric hospital stays are meant to stabilize the patient and relieve symptoms and may not necessarily result in full recovery or remission. The collective role of hospital providers and community care teams deserves further exploration in order to establish which elements of care can reduce re-hospitalization risk.

Theoretical Framework

To develop sound treatment strategies following discharge, care providers need reliable information about which factors place patients at higher risk of returns to the hospital and which potentially modifiable factors are related to improved outcomes. The development and testing of valid theories regarding underlying reasons related to psychiatric re-hospitalization represents an important step to reducing occurrences of repeated psychiatric hospitalizations.

Several established theories have guided decades of research regarding factors that influence the use of healthcare services. For example, Andersen's Behavioral Model (1973) has been widely adopted to examine the effect of predisposing factors; enabling factors and need for services on treatment utilization. Similarly, prior theoretical models such as the Health Belief Model (Irwin, 1974) and Theory of Reasoned Action (Fishbein, 1980) were used to examine use of primary health care services, but had not been widely adopted to explain mental health treatment seeking (McAlpine & Boyer, 2007). However, there are several reasons that models centered on primary care utilization are unsuitable for studying mental health treatment seeking. First, a defining feature of serious mental illnesses such as schizophrenia is an inability to recognize the presence of symptoms or the capacity to mask symptoms in social situations. This lack of awareness, called anosognosia, may interfere with the perception of need. While an understanding about need for treatment may be central to medically-based models of care, this factor may not be relevant for mental health treatment-seeking. Second, traditional models related to health services utilization consider the treatment decision as a single, discrete event. The course of illness for mental health disorders, however, does not necessarily resemble the progression of chronic medical conditions. Individuals with serious mental illnesses may experience the recurrence of acute symptoms multiple times following initial onset of the disorder. Consequently, engagement in mental health treatment may be best defined as episodes of involvement in care, rather than single treatment events.

A theoretical framework first proposed by Klinkenberg and Calsyn (1996) represents the first model specifically related to acute psychiatric care. This oft-cited model (see *Figure 2*) was based on a literature review of psychiatric re-hospitalization studies conducted between 1974 and 1994 and categorized observed factors into four dimensions - client vulnerabilities, community

support, system responsiveness and receipt of aftercare. The literature review identified only two

variables related to client vulnerability that were related to re-hospitalization risk – previous

psychiatric admissions and medication non-compliance. In terms of community support, the

authors concluded that social or family networks may play potential roles in return psychiatric

visits, but this measure was not defined consistently across studies. Finally, in relation to system

responsiveness, Klinkenberg and Calsyn concluded that the effectiveness of traditional case

management on re-hospitalization was still unclear, and further research into intensive support

with multidisciplinary teams was warranted.
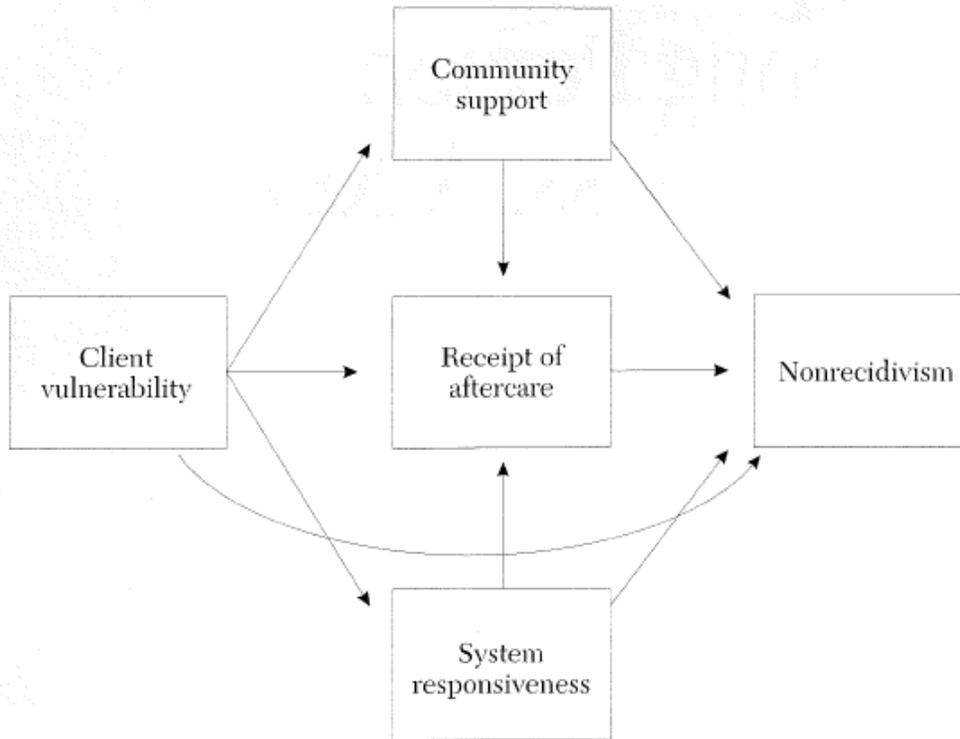
Figure 2. Klinkenberg and Calsyn Model of Recurrently Readmitted Psychiatric Patients

In short, the body of research compiled over this twenty-year span (1974-1994) provided

little guidance in understanding why some patients may return to the hospital following inpatient

psychiatric treatment. The research was primarily based on small, non-representative samples

with a limited number of predictor variables. However, the authors noted that this attempt to develop an investigative framework represented a "first-step" in applying theory to the study of psychiatric re-hospitalization.

Later models of mental health treatment included multilayered explanations of care seeking. The Network Episode Model proposed by Pescosolido and Boyer (2010) conceptualized mental health treatment as a social process influenced by the cumulative experience of patients interacting with treatment systems and supports over an "illness career". The model theorized that persons may be influenced more by beliefs and perceptions of care rather than by a calculation on the costs and benefits of seeking treatment. While the Network Episode Model accounted for the importance of care transitions and longitudinal nature of mental health care utilization, the model does not address factors that lead to psychiatric hospitalization in general, or repeated hospitalizations in particular.

The Risk Identification Model was developed from a phenomenological study conducted by Mgutshini (2010) in which both clinicians and patients were interviewed regarding reasons for psychiatric hospitalizations. A review of case notes and focus group responses were used to distinguish single admission from multiple admission patients. Not surprisingly, clinicians tended to emphasize medical risk factors while patients emphasized social disruptions, such as financial difficulties or loss of a relationship. The authors acknowledge that this model is intended to provide a qualitative framework that highlights situational circumstances preceding psychiatric hospitalization. However, the exploratory findings from the Risk Identification Model present several variables that could be incorporated in a more structured assessment of psychiatric re-hospitalization risk. The authors group these factors into "pathway" and "gatekeeper" variables that may be used to identify risk of psychiatric re-hospitalization.

Themes developed from the Risk Identification model are important because they suggest that certain patients may be more susceptible to difficulties in the community following psychiatric discharge. Sledge and Dunn (2009) describe these "Recurrently Readmitted Inpatient Psychiatric Patients" (RRIPP) as a distinct subset of individuals with serious and persistent mental illness that become increasingly disconnected and prone to acute hospitalizations:

What emerges from the fog of time and multiple studies across cultures is a group of patients who tend to be difficult to engage with most institutions (mental health treatment programs, employment and educational organizations) and people (family, friends, coworkers, etc.) for a variety of reasons and to whose needs organizations have trouble accommodating. (p. 240)

Sledge and Dunn suggest that the inability to engage in treatment should be considered as a critical factor in explaining recurrent re-hospitalizations. This hypothesis was used to modify the original theory proposed by Klinkenberg and Calsyn (1996). Under the Sledge and Dunn RRIPP framework (see *Figure 3*), client vulnerabilities, community support and system responsiveness may only play a role for those patients that show a capacity for treatment engagement. The level of engagement, or lack thereof, stands as a defining characteristic that separates re-hospitalized patients from those that do not return to the hospital following an inpatient psychiatric stay (Schmutte, Dunn, & Sledge, 2009; Sledge, Dunn, & Schmutte, 2008).

This dissertation research draws on the RRIPP theory of engagement proposed by Sledge and Dunn and utilizes a recurrent event history model to distinguish disengaged patients following the first psychiatric discharge. Consistent with this theory, Cuffel, Held and Goldman (2002) found that despite an increase in outreach and discharge planning services, high-risk
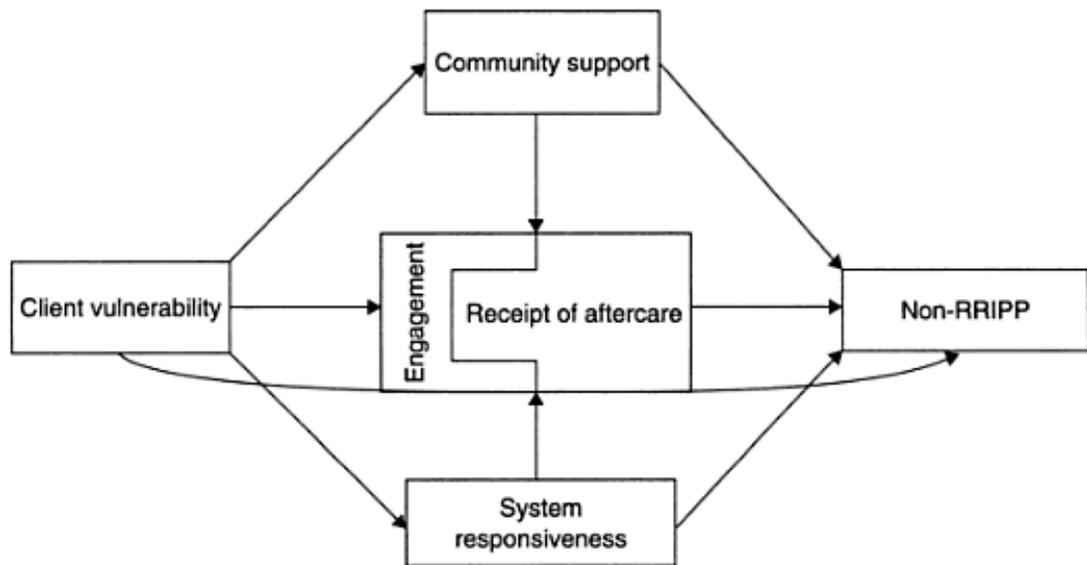
Figure 3. Sledge and Dunn Framework: Recurrently Readmitted Inpatient Psychiatric Patients

patients did not follow-up with outpatient care plans and did not experience a subsequent reduction in re-hospitalization rates. The aim of this research is to determine which dimensions might be used to identify high-risk patients at the early initial stages of inpatient treatment when engagement efforts may be more successful.

State-of-the-Science

The purpose of the current literature review is to select, evaluate, and synthesize the research literature on psychiatric re-hospitalization with a focus on the progressive development of risk factors. There are three important reasons to provide an update on the state of the science in relation to psychiatric re-hospitalization. First, the most recent systematic reviews on this topic were published in 2009 (Sledge & Dunn) and 2012 (Machado, Leonidas, Santos, & Souza). Contemporary reviews, however, included studies from the United States that were completed in 2004 or earlier. In recent years, many changes have occurred in the United States related to

mental health care and a current assessment is important to evaluate the present nature and scope

of the re-hospitalization phenomenon. Second, it is more feasible to explore questions on

historical hospital visits with the increasing availability of longitudinal datasets. In 2010, for

example, the Agency for Healthcare Research and Quality (AHRQ) first released a research

dataset called the "revisit" file which permitted the linking of hospital discharges for given

patients over a five-year period (Healthcare Cost and Utilization Project, 2017). Finally, existing

systematic reviews related to psychiatric re-hospitalizations have been undertaken from the

vantage point of a particular field, such as sociology, nursing or psychology. This review makes

a concerted effort to approach this problem from an interdisciplinary perspective, drawing on

literature from healthcare management, social work, nursing, and psychiatry.

Literature search results. The electronic literature search resulted in **554 unduplicated**

citations with relevant information on psychiatric inpatients. The abstracts for each of the

resulting articles were screened to determine if the study met review criteria (see *Figure 4*). The

inclusion criteria for the review involved the following conditions: 1) the study was published

between 2000 and 2016, 2) the study measured psychiatric re-hospitalization with verified

discharge or clinical records as an outcome, and 3) the study group included an adult patient

population. Given that the current dissertation research sought to examine the impact of recurrent

hospitalizations following deinstitutionalization, studies that were conducted outside the United

States were excluded (n=326). In addition, this review sought to specifically examine the role of

community supports, so studies based in specialty state psychiatric hospitals (n=15), Veteran's

Administration (VA) facilities (n=33) or children's psychiatric units (n=15) were also excluded.

Finally, patient populations hospitalized primarily for substance abuse disorders were not

considered (n=17), although the presence of co-occurring (mental health and substance)

disorders was permitted. The selection process resulted in **74 articles** that were reviewed to assess the state of science related to factors associated with psychiatric re-hospitalization.

A full-text review of these articles found that several studies were not relevant to factors associated with psychiatric re-hospitalization (n=4), focused on a distinct patient populations (n=7) or populations that had not experienced a first hospitalization (n=3). In addition, there were seven published manuscripts that reviewed available evidence and current issues related to frequent psychiatric hospitalizations. A detailed systematic review was completed for the remaining **53 articles**. The validity of a number these articles (n=9) was questioned based on poor methodological approaches or incomplete reporting. A qualitative assessment was conducted for **44 studies** that examined characteristics and outcomes for patients with recurrent psychiatric hospitalizations. A synthesis of available findings and critique of this evidence is included in the next section. This summary also includes a quantitative synthesis detailing the methodology, study setting, and findings for **21 articles** that reported psychiatric re-hospitalization rates and predictive factors.

Synthesis of evidence. This dissertation literature review will categorize factors based on the conceptual framework first proposed by Klinkenberg and Calsyn (1996) – client vulnerabilitfcies, system responsiveness, and community support. As previously noted, the Klinkenberg and Calsyn model delineates between patient-centered factors, such as demographic or clinical characteristics, and treatment processes or other structural factors.

Patient vulnerabilities. The most commonly referenced predictors of psychiatric re-hospitalization have involved patient-centered variables. Sociodemographic variables, such as gender, age, race and ethnicity have been studied widely. However, available studies have failed to reach consistent conclusions about the nature of demographic risk factors associated with re-

hospitalization (Pescosolido & Boyer, 2010). Only one of the studies examined in a systematic review uncovered statistically significant differences in re-hospitalization outcomes between male and female patients. This study, conducted by Grossman et al. (2006) involved a prospective analysis of 239 patients (119 women and 120 men) that were discharged from a psychiatric hospital at a relatively young age (M=23 years) and followed over a 15-year time period. The authors found that women with schizophrenia and other psychotic disorders experienced improved functioning (F(1, 184)=7.41, p<.01) and lower ten-year re-hospitalization rates (χ^2(1)=12.09, p<.01) compared to similarly diagnosed men. For patients with non-psychotic disorders (n=144), there were no sex-related differences in outcomes. The analysis by Grossman suggests that sex may only be an informative prognostic indicator for re-hospitalization if considered in conjunction with age of onset and psychiatric diagnosis.

Race or ethnicity did not demonstrate a significant association with psychiatric re-hospitalization in any of the 13 studies where this factor was included as a covariate. A risk-adjustment analysis by Hendryx, et al. (2001) found differential effects for African-Americans but these effects disappeared when interactions for court-ordered treatment and previous state hospitalizations were included in the model. A novel study completed by Mathews et al. (2002) tested the effect of placing 5,983 psychiatric patients in ethnically-focused units of an urban community hospital. The authors did find any difference in one-year re-hospitalization outcomes between patients in matched and unmatched units. Based on available research, a patient's race and ethnic background does not appear to be a relevant covariate when examining risk factors for psychiatric re-hospitalization.

Adjusted models from six of the studies in this dissertation literature review indicated a reduced risk of re-hospitalization as patient age increased. This finding may appear intuitive

since the age of onset for many psychiatric disorders occurs during early adulthood. However, this finding should not suggest that elderly patients are not vulnerable to psychiatric re-hospitalizations. The systematic review conducted for this analysis identified three different studies focused on a geropsychiatric population. Nearly one-quarter (22-23%) of elderly psychiatric patients followed in these studies were re-hospitalized within six-months of discharge. Furthermore, in a one-year follow-up of 5,929 patients with psychiatric discharges, Snowden et al. (2004) found that geriatric patients had the same adjusted risk of re-hospitalization as younger patients. In addition to demographic factors and diagnoses, this analysis controlled for symptom severity using the Psychiatric Symptom Assessment Scale (PSAS). The results indicate that symptom distress may heighten the risk of re-hospitalization among older patients and acuity severity, or course of illness should also be considered in predictive models. The current research literature shows a consistent and clear effect of age on psychiatric re-hospitalization outcomes and this important variable should be considered in any comprehensive study in this area.

While nearly every study in this dissertation review included information about patient diagnoses, there were conflicting findings regarding the relationship between re-hospitalization risk and type of psychiatric disorder. For example, the review of research literature conducted by Sledge and Dunn (2009) reported that psychosis was the most common condition linked to repeated psychiatric hospitalizations. However, this contention has not been supported in earlier reviews, and as Klinkenberg & Calsyn (1996) noted, "most studies that examined this variable reported no association between diagnosis and recidivism. These findings support those of previous studies, in which diagnosis did not consistently predict recidivism." (p. 491).

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│ Citations identified through│   │ Additional citations from references of   │
│    database searching        │   │ included studies or abstracts of relevant │
│         (N=742)              │   │         societies (N=12)                   │
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Citations identified through database searching (N=742)

Additional citations from references of included studies or abstracts of relevant societies (N=12)

Citations after duplicates removed (n=593)

Citations not relevant (n=39)

Abstracts screened (n=554)

Abstracts excluded
Not U.S.=326
No Inpatient Stay=49
No Re-hospitalization=25
State Hospital=15
Veterans=33
Children=15
Substance Use Only=17

Articles assessed for eligibility (n=74)

Articles excluded
Literature Review=7
Specialized Population=7
Not Relevant=4
No Inpatient Stay=3

Studies included in qualitative synthesis (n=53)

Studies included in quantitative synthesis (n=21)

Figure 4. Flow Diagram of Systematic Review Selection Results.

While studies by Manu, et al. (2014) and Schmutte et al. (2009) reported that psychotic disorders predicted risk of re-hospitalization, other studies were more equivocal. Kolbasovsky, Reich & Meyerkop (2010) reported no inter-diagnostic differences in adjusted six-month re-hospitalization rates among patients with depression, bipolar, psychotic and anxiety disorders. Despite the fact that diagnostic criteria may not independently predict re-hospitalization, this covariate may have a differential impact in relation to other patient factors (such as gender) and should be included in a complete analysis of risk factors.

In addition to psychiatric diagnosis, a patient's functional ability may also be an important aspect re-hospitalization risk. The Global Assessment of Functioning (GAF) represents a common clinician-rated measure of functioning and symptom severity (American Psychiatric Association, 2000). Three of the reviewed studies included this measure as an independent variable, but the GAF score was not a significant predictor of psychiatric re-hospitalization in any (Clements, Murphy, Eisen, & Normand, 2006; Hendryx et al., 2001; Lang, Rohrer, & Rioux, 2009). The reliability and validity of the GAF has been criticized, particularly since the score represents a measure of both symptoms and functioning (Aas, 2010). An alternative approach employed by Schmutte, Dunn and Sledge (2010) found that the unemployment (OR=9.26, 95% CI [1.27, 67.42], p=.03) and supervised residential living status (OR=2.05, 95% CI [1.04, 4.06], p=.03) were significantly associated with a shorter time to re-hospitalization and may serve as useful proxies for limitations in functional capacity. While generalized instruments of functional capacity do not appear to be useful indicators of re-hospitalization, measures of independent living and community integration may merit further examination.

The body of literature on psychiatric hospitalization outcomes includes a heavy emphasis on patient characteristics and vulnerabilities. As reported in this dissertation literature review, the effect of these observed socio-demographic and clinical factors is often mixed. The one trait that has consistently emerged as a distinguishing factor in re-hospitalization risk is a patient's prior history of psychiatric admissions. Seven studies included in this review controlled for the number of previous hospitalizations, and in each study, this history was associated with a significantly higher risk of re-hospitalization. While influence of prior hospitalizations has been a prevailing theme in decades of literature on recurrent patients, this evidence has a somewhat narrow practical application as noted by Mgutshini (2010):

> Knowing that clients who have been repeatedly admitted are at highest risk of future admissions is helpful in ensuring that support and specialist interventions are targeted towards established recidivists but, critically, has no value as a preventative aid to first-time admittants or indeed service users who have not been hospitalized before. (p. 262)

While psychiatric hospitalization history provides a constructive indicator of static risk, other modifiable attributes or supports should also be considered in an effort to reduce the burden of recurrent hospitalizations.

Community Support. A holistic examination of patients that cycle through the inpatient psychiatric treatment system should recognize that acute hospitalization is a complex process that involves both clinical and social aspects (Loch, 2014; Sullivan et al., 1997). There are both formal and informal support structures that may influence re-hospitalization. From an informal perspective, family involvement, or lack thereof, can play a dual role in help-seeking outcomes for adults with a psychiatric disorder. Family environments for persons with schizophrenia, for example, are often characterized by the level of critical over-involvement. This conflict, called

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expressed emotion, may trigger symptom relapse and subsequent re-hospitalization in some

patients (Donat, 1996; Grossman et al., 2006). Family psychoeducation programs that involve

relatives of patients with schizophrenia have been shown to reduce relapse rates by as much as

20 percent over 12 months (Pitschel-Walz, 2004). The authors of the meta-analysis with this

finding note, however, that this result only extends to patients with relatives that are willing to

become engaged with treatment efforts following discharge. The differential impact of family

involvement was also highlighted in a study completed by Boyer, et al. (2000) who found that

family involvement with the treatment team significantly increased the odds of post-discharge

engagement by nearly four times (OR=3.74, 95% CI [1.34, 10.41], p=.01). However, less

intensive efforts, such as in-hospital family visits or a discussion of discharge plans with family

members were not significantly related to treatment engagement following a psychiatric

hospitalization. While social supports may be associated with positive discharge outcomes in

some cases, covariates related to family involvement should be interpreted with caution, given

identified selection issues.

The circumstances by which patients are admitted to a psychiatric hospital should also be

included in discussions of community support. Civil commitment statutes in all 50 states

authorize an involuntary hospitalization in cases where an individual poses a danger to self or

others as a result of a mental illness (Testa & West, 2010). In 46 states, an individual may also be

subject to an "assisted outpatient treatment" court-order for compulsory treatment following an

involuntary inpatient discharge (Washington State Institute for Public Policy, 2015). Despite the

consequence and visibility of involuntary treatment laws, there is little research available about

the effectiveness of this type of coercive support (Katsakou & Priebe, 2006). Craw and Compton

(2006) studied differences by legal status for 277 patients discharged from two psychiatric units

in Atlanta, Georgia. While 65% of voluntary patients had been previously hospitalized, 84% of those treated on an involuntary basis had a prior psychiatric hospitalization. Although evidence related to court-involvement is limited, involuntary treatment laws play a key role in admission decisions and the relationship between legal conditions, treatment engagement and hospitalization outcomes should be assessed further.

Finally, the provision of public insurance and income support represents another external factor that should be considered. Three of the studies included in this dissertation literature review focused exclusively on inpatients with public Medicaid health insurance. The largest, a five-state study of Medicaid claims over two-years, found that 24% of adults diagnosed with depression were re-hospitalized within three months (Prince et al., 2009)**.** Similarly, a four-year analysis of Florida Medicaid recipients diagnosed with schizophrenia reported that 23% re-entered the hospital within 30 days (Boaz et al., 2013). Finally, Hendryx et al. (2003) tested the impact of outpatient services on psychiatric re-hospitalization for public-pay patients in Seattle, Washington and observed an 11% return rate after 60 days. All three of these studies noted the additive risk of substance abuse disorders on re-hospitalization rates. The Hudson study (2005) that analyzed patterns of psychiatric hospital use over a seven-year period was the only reviewed study that considered differences in insurance status among an all-payer population. Medicare/Medicaid fee-for-service patients were the most likely to be classified as occasional/extended users (24-27%) compared to patients in all other payer groups (10-21%). Given the costs associated with psychiatric hospitalization and the comparatively high rates of re-hospitalization among Medicaid patients, payer status should be taken into account in any comprehensive analysis of this topic.

While payer status remains a critical component of research on psychiatric re-hospitalizations, there are several cautions that should guide interpretation of this factor. First, insurance status represents a fluid construct that may change over time as individuals gain or lose different levels of coverage. The cross-sectional approach employed in many models of re-hospitalization does not permit the addition of this type of dynamic variable. Second, the act of seeking or maintaining insurance may coincide with a patient's need for treatment. This creates an obvious simultaneity bias given that sicker individuals may be more likely to select coverage. However, starting in 2014, new health reforms implemented under the Patient Protection and Affordable Care Act (ACA) will require persons to carry a minimum level of health insurance or face a tax penalty. This new individual mandate, and other large scale changes brought about by the ACA, will reshape the health care system in the United States and require a re-examination of questions related to access, affordability and utilization of mental health-related services (Mechanic, 2014). These recent developments point to the need for additional longitudinal research on the importance of health insurance and other social supports for patients needing acute psychiatric care.

System responsiveness. While psychiatric re-hospitalization may be partly attributed to symptom deterioration or a breakdown in community or social supports, treatment effectiveness–both in-hospital care and transitional care following discharge - should also be examined as potential explanations of patient outcomes. Unfortunately, current research literature only highlights one aspect of inpatient care - length of a patient's hospital stay – as a potential indicator of re-hospitalization risk. While ten of the studies in this review controlled for length of stay, only four reported that increased inpatient treatment time was associated with a significant reduction in re-hospitalizations. However, as noted previously, a patient's level of engagement

and response to treatment may vary with each subsequent hospitalization (Figueroa, Harman, & Engberg, 2004). Therefore, length of stay should be evaluated in the context of patient care episodes, rather than as a fixed construct with a singular effect.

While this dissertation literature review primarily focused on factors observed during the index psychiatric hospitalization, those strategies that are employed following discharge have also been addressed in the research literature. An Agency for Healthcare Research and Quality (AHRQ) technical brief (Gaynes et al., 2015) found that the majority of available studies addressed four interventions: crisis residential care, case management, involuntary outpatient commitment/compulsory treatment orders, and Assertive Community Treatment (ACT). The review noted that variation in both implementations of the intervention and definitions of successful outcomes precluded firm conclusions on the effectiveness of these post-discharge models. In a similar review of over 500 peer-reviewed articles related to psychiatric re-hospitalization, Vigod, Taylor, Fung & Kurdyak (2013) found only 15 studies with rigorous evaluation of transitional interventions. The authors concluded that:

> clinical heterogeneity of the studies also limits our ability to generate practice and policy implications from the data. The wide variation in readmission rates between the studies suggests that these interventions were applied in populations with different levels of risk. This limits our ability to comment on how effective some of these interventions might have been in populations with different baseline levels of risk for readmission. (p. 192)

The literature compiled on the problem of psychiatric re-hospitalization is remarkably concordant in the view that a distinct class of "revolving-door" patients seem to exhibit a level of instability and disengagement that places them at higher risk of repeated hospitalizations. The

lack of reliable findings on the effect of post-discharge treatment highlights the fact that research should span both inpatient and outpatient encounters over an extended period.

Evidence critique. A critique of acute psychiatric care studies reveals that contemporary research has yet to provide a comprehensive knowledge base related to risk factors for re-hospitalization. Several systematic reviews of the available literature have concluded that theoretical and methodological limitations in this work have made it difficult to draw generalizable conclusions about psychiatric re-hospitalization outcomes (Gerolamo, 2004; Klinkenberg & Calsyn, 1996). Methodological limitations include: the lack of a consistent standard definition for the time to re-hospitalization, the use of relatively small samples that focus on returns to the same hospital and a reliance on modeling approaches that focus on a single re-hospitalization, rather than multiple hospitalization episodes. From a theoretical perspective, current studies are often constrained by a narrow focus on clinical and demographic information that is typically available from the patient's discharge record. In many cases, there is no theoretical underpinning to existing studies whatsoever, leaving a body of findings that lack consistency and structure.

The lack of cohesive findings related to risk of psychiatric re-hospitalization may be attributed partly to the fact that there is wide variation in how the period of re-hospitalization is defined in the available literature. Table 1 presents 13 studies from the dissertation literature review that are based on a general adult population. Specialized patient groups, such as public pay (Medicaid), elderly, and general hospital admissions, are included in the eight studies listed in Table 2. As this summary shows, several researchers (n=8) have considered rapid, or early hospital returns that occur within 30-90 days of the index discharge. Nearly half of the studies examined (n=10) focused on re-hospitalization outcomes within a six to fifteen-month time

period. And, a selected number of studies (n=3) followed re-hospitalization activity for an extended period ranging between two and fifteen years. Wide discrepancies in the operational definition of re-hospitalization make it difficult to conduct a rigorous and systematic analysis of the evidence using techniques such as meta-analysis (Averill, Hopko, Small, Greenlee, & Varner, 2001; Durbin, Lin, Layne, & Teed, 2007). The disparate approach in the available research literature may account for the difficulty in identifying which demographic, psychiatric, and hospital-related variables are most predictive of re-hospitalization.

Studies examining psychiatric re-hospitalization are also characterized by an overreliance on cross-sectional methods, as opposed to longitudinal approaches (Webb, Yágüez, & Langdon, 2007). In the studies examined for this dissertation literature review, logistic regression represented the most common technique used to estimate the probability of re-hospitalization (n=12). These models focus on a single hospitalization event, but may ignore factors associated with patients that are hospitalized when the study observation period ends. Cox proportional hazard, also called survival or duration models, represent the second most common approach to modeling time to psychiatric re-hospitalizations (n=6). In all but one of these studies, however, the dependent variable was based on time to the first subsequent hospital event, and lacked information on the recurrence of hospitalization episodes over time.

Table 1

Synthesis of Evidence Related to Psychiatric Re-Hospitalization – All Inpatients

Citation	Sample Size (N)	Outcome (%)	Method	Setting
Lang et al., 2009	184 adults	30 days (10%)	logistic regression	inpatient psychiatric facility in rural MN
Taylor et al., 2014	195 adults	30 days (26%)	logistic regression	large psychiatric specialty hospital in Pittsburgh, PA
Rylander et al., 2016	693 adults	90 days (10%)	logistic regression	inpatient behavioral health unit in Denver, CO
Hendryx et al., 2003	1,384 adults	12 months (8%)	stepwise logistic regression	Seattle medical center (readmissions to any WA hospital)
Snowden et al., 2004	5,929 adults	12 months (19%)	logistic regression	Seattle, WA (Harborview Medical Center)
Schmutte et al., 2010	150 adults	12 months (30%)	Cox regression (single episode)	integrated health system in CT
Clements et al., 2006	1,034 adults	12 months (33%)	logistic regression	inpatient facility in MA
Craig et al., 2000	402 nonelderly adults	12 months (36%)	chi-square (rapid versus delayed readmission)	12 psychiatric facilities in Suffolk County, NY
Mathews et al., 2002	5,983 adults	12 months (61%)	Cox regression (single episode)	San Francisco General Hospital Psychiatric Unit
Manu et al., 2014	945 adults	12 months (24%)	logistic regression	academic freestanding psychiatric hospital in New York City
Moran, Doerfler, Scherz, & Lish, 2000	370 adults	15 months (28%)	logistic regression	psychiatric inpatient unit of teaching hospital in central MA
Hudson, 2005	47,787 first-time patients	7 years (30%)	cluster analysis of patient typologies	hospitalized in acute care psychiatric unit in MA
Grossman et al., 2006	239 young adults	15 years (31% female, 40% male)	repeated measures ANOVA	Chicago follow-up study

Table 2

Synthesis of Evidence Related to Psychiatric Re-Hospitalization –Patient Subgroups

Citation	Sample Size (N)	Outcome (%)	Method	Setting
Medicaid				
Boaz et al., 2013	3,563 nonelderly adults	30 days (23%)	Cox regression (recurrent events)	Florida state Medicaid claims
Hendryx et al., 2001	1,616 adults	60 days (11%)	stepwise logistic regression	community or state psychiatric hospital treatment in OK
Prince et al., 2009	30,888 nonelderly adults	90 days (24%)	Cox regression (single event)	Medicaid claims in five states (California, Florida, New Jersey, New York, and Texas)
General Hospital				
Kolbasovsky, 2009	652 adults	30 days (29%)	logistic regression	Managed care organization in New York State
Figueroa et al., 2004	5,735 hospital discharges	30 days (14%)	two stage logistic regression with instrumental variable	United States employer-based private insured; Marketscan data
Elderly				
Prince et al., 2008	41,839 elderly adults	6 months (22%)	Cox regression (single episode)	national sample of Medicare beneficiaries (MedPar files)
Morrow-Howell et al., 2006	199 elderly adults	6 months (23%)	Cox regression (single episode)	geropsychiatric unit of teaching hospital in urban Midwest
Woo et al., 2006	424 elderly adults	20 months (36%)	logistic regression	University of California, San Diego Senior Behavioral Health Unit

Many studies related to psychiatric re-hospitalizations only follow patients within a single health system or hospital. Conclusions from these single site studies are often based on a small sample size and may be constrained by insufficient power to detect differences (Gaynes et al., 2015). In addition, without the ability to follow patients across a network of hospitals, studies may fail to capture the re-hospitalization outcomes of interest. A seven-year longitudinal study of 47,787 psychiatric inpatients in Massachusetts, for example, identified clusters of patients with frequent hospitalizations. While those patients characterized as "stable" (n=1,638) had returns to an average of 1.5 hospitals, another group of "transient" patients (n=700) visited an average of 3.4 hospitals during the study period (Hudson, 2005). The question of psychiatric hospital mobility was examined explicitly by Vigod (2013) in a study of psychiatric hospitalizations in Ontario, Canada. This system-wide study found that a median of 27% of all 30-day psychiatric re-hospitalizations occurred to a facility other than the discharging institution. This finding emphasizes the importance of examining returns to multiple hospitals to accurately gauge the extent of returns to psychiatric care.

The scope of data employed for these reviewed studies may also limit the type of conclusions that can be drawn from existing research. Administrative records taken at hospital admission or discharge are commonly used in research on psychiatric re-hospitalizations. While these records provide an official verification of the hospital event, studies that rely exclusively on discharge data may have an overreliance on the demographic and clinical aspects associated with outcomes (Bridge & Barbe, 2004; Prince et al., 2008). Patient behavior and functioning, social engagement, and involvement of family members or other supports are missing in studies that focus solely on clinical vulnerability. In addition, particularly in longitudinal studies, it may

also be important to follow adverse outcomes such as patient death and institutionalization (in state hospital or jail) when assessing risk of returns to the hospital.

Finally, the lack of theory-based research has also impeded the advancement of consistent and cohesive research findings on risk factors associated with psychiatric re-hospitalizations. The systematic review conducted by Gerolamo (2004) noted the atheoretical nature of prior research on this topic. This assessment echoed conclusions presented by Montgomery and Kirkpatrick (2002)**,** which explored implications of this knowledge deficit from the nursing perspective:

> In conclusion, the concept of re-hospitalization and its predictors are multidimensional. The literature suggests that theoretical and methodological limitations make it difficult to predict the risk of re-hospitalization. Recognizing differences in its subjective and objective meaning as well as its functionality for a subgroup of persons with severe and long-term mental illness may be an initial step toward understanding its relevance, if any, in the planning of care. (p. 22)

This dissertation literature review also found a shortage of theory-based research. Two different studies (Lee, Rothbard, & Noll, 2012; Rozario, 2006) utilized the Andersen Behavioral Model of Health Services Use to examine enabling, predisposing and need-related factors related to psychiatric re-hospitalization. As previously noted, the study by Cuffel et al. (2002) employed the RRIPP framework to test the effects of patient characteristics and vulnerabilities relative to changes in treatment approaches. Future research should remain grounded in theory to determine which conceptual models may be useful in developing effective responses to reduce the burden of recurrent psychiatric hospitalizations.

Literature Gaps

Despite an extensive base of research surrounding psychiatric hospitalizations, there are notable gaps that remain in the available literature. First, current evidence and theories have focused on the number of prior psychiatric hospitalizations as a key indicator of interest. A count of previous admissions, however, assumes that each successive hospitalization contributes equally to ongoing risk. As Lyons (1997) notes, psychiatric hospitalization patterns may vary according to the severity, duration and episodic course of illness. Additional research is needed that incorporates the timing and sequence of events to determine how the elements of risk change following the initial hospitalization.

Second, key variables related to patient outcomes seem to be absent in the contemporary research literature. For example, the extent of patient mobility, or "hospital shopping", is rarely explored, given that many studies focus on a single hospital system or medical center. In addition, events that occur between hospitalizations are seldom incorporated in studies of psychiatric inpatients. Given that community hospital stays are generally short in duration, additional signs of risk may develop in the weeks or months following discharge. For example, emergency-department visits (Chang, Weiss, Orav, & Rauch, 2014), social service encounters (Beadles et al., 2015; Nelson, Maruish, & Axler, 2000; Vijayaraghavan, Messer, Xu, Sarkin, & Gilmer, 2015), and jail bookings or arrests (Swanson, 2015; Van Dorn, Desmarais, Petrila, Haynes, & Singh, 2013) may indicate difficulties with community integration following a psychiatric hospitalization. While studies assessing re-hospitalization have largely focused on static, easily observable factors, those aspects of risk that fluctuate over time should also be addressed.

Finally, current studies primarily evaluate the likelihood of a single event – the first re-hospitalization that occurs following the index admission. It is important to recognize that psychiatric disorders are characterized by variability in onset, recovery and relapse over the lifespan (Haghighat, 1996; Liberman & Kopelowicz, 2005; Solomon et al., 2000). There are two potential limitations of analyses that only encompass a single episode: 1) with each successive episode, the time to recurrence grows shorter for patients with repeated hospitalizations, and 2) patients with multiple episodes are more likely to be over-represented in analyses taken at an arbitrary point in time (Kessing & Andersen, 2005).[2] Additionally, key information may be lost by examining the first observed re-hospitalization, since a patient may still be at risk beyond this initial failure.

A thorough review of research on psychiatric re-hospitalization reveals a shortage of studies the follow long-term patterns of inpatient treatment. Studies of psychiatric populations in other counties, such as Germany (Frick et al., 2013), Denmark (Kessing, Andersen, & Mortensen, 1998), and Iran (Rahmati, Rahgozar, Bakhshi, Cheraghi, & Fadaei, 2015), have used approaches that evaluate the likelihood of multiple hospitalizations over time. The ongoing debate about the availability and use of psychiatric inpatient care facilities in the United States calls for an approach that recognizes re-hospitalization as a dynamic process, rather than a binary outcome. The analysis discussed in the next chapter proposes using recurrent event history modeling to estimate re-hospitalization risk over a five-year period among psychiatric inpatients in Washington State.

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[2] The concept of that a group of heavy users can bias an analysis conducted in a given period of time was first introduced in 1938 and came to be known as Slater's Fallacy. See Haghighat (1996) for a historic review.

Chapter Three

Methodology

Introduction

  The primary goal of the current dissertation research involves developing and testing improved models for estimating the hazard of psychiatric re-hospitalization. As discussed in Chapter Two, existing research literature often focuses on a single re-hospitalization as the primary outcome of interest, despite the fact that psychiatric illnesses are characterized by variation in the timing and intensity of repeated episodes (Baethge & Schlattmann, 2004). The methodological approach detailed in this chapter describes the use of a survival analysis for recurrent events to account for the changing dynamic of hospitalization risk over time.

  This retrospective observational cohort study relies exclusively on administrative records collected from community hospitals in Washington State. The use of administrative data for health services research presents a powerful and efficient means to examine patient outcomes that may be otherwise difficult to study, given time and resource constraints (Smith et al., 2011). The use of secondary administrative data permits an analysis of the entire population of interest, eliminating the need to recruit and retain a representative sample. Hospital administrative discharge records also contain a large number of patient observations with rich detail on a patient's clinical acuity, financial circumstances and geographic location (Kornegay & Segal, 2013). Important to the purpose of this study, hospital administrative discharge records include a multi-year chronology of inpatient hospital utilization that would be difficult to collect in prospective manner. The analysis of secondary data is becoming increasingly accepted as an important way to uncover real-world trends, test and develop research hypotheses, and

disseminate findings that can be replicated and expanded to inform clinical care (Dunn, Arslanian-Engoren, DeKoekkoek, Jadack, & Scott, 2015). The intent of this dissertation research is to leverage this available secondary data to extend existing approaches related to the study of psychiatric re-hospitalization risk factors.

There are notable disadvantages to conducting a secondary analysis of existing data as well. The primary shortcoming of this approach lies in the absence of a diverse set of indicators about the subject of interest. For example, data collected during a hospital stay generally include demographic, clinical and financial information related to providing care. Detail about a patient's level of independence and functioning, social supports or stressors, contributory behaviors and views on treatment are typically not captured in the hospital discharge record (Loch, 2014). Analyses using administrative records should always consider the primary purpose for which data are collected and recognize that the consistency and accuracy of information may be affected by billing guidelines, staff experience, and reporting requirements (National Institutes of Health, 2009).

Even given the limitations of secondary analysis of existing data, a well-constructed observational study can provide important information on a phenomenon of interest and lay out a path for future studies of clinical import. The quality of a non-randomized observational patient cohort study can be evaluated along three dimensions related to selection, comparability, and outcome assessment (Stang, 2010). The selection of the study group requires that all subjects are assessed at a common point in the course of illness, with an outcome that is measured consistently and objectively. The comparability of an analysis indicates that the study includes the prognostic variable of interest and controls for other potential confounders. Adequate outcome assessment is present if patients have been followed for a sufficient period for the

outcome to occur. Finally, to be considered generalizable, study results should be widely validated. The remainder of this chapter is organized into the following four sections that address each of these components: 1) study population, 2) data collection, 3) variable definitions, and 4) analytical plan.

Study Population

The patient population in this study includes adults admitted to Washington State specialty psychiatric hospitals or community hospitals with a designated psychiatric unit. The American Hospital Association (AHA) defines community hospitals as "nonfederal, short-term general, and other special hospitals" that are accessible by the general public (American Hospital Association, 2016). There were 100 community hospitals operating in Washington State in 2015, with five designated as specialized psychiatric hospitals and thirteen that included a dedicated psychiatric unit within the hospital (Washington State Department of Health, 2016).

The specific population of interest for this study includes those adults (18+ years of age) admitted for a first-time psychiatric hospitalization between 2012 and 2015. Since a full lifetime history of psychiatric hospitalizations is unavailable, a 'first-time' patient in the present study is defined as those individuals without any psychiatric admission in the three years prior to the index hospitalization. While this index hospital stay may not be the patient's first-ever hospitalization, restricting the study population to those patients without an observable history improves the likelihood that patients are comparable and not presently experiencing a series of hospitalizations.

Inclusion criteria. Several additional criteria were used to select the adult patient population from short-term psychiatric hospitals. Hospitals include the facilities licensed and certified by the Washington State Department of Health (DOH) to provide inpatient psychiatric

treatment and acute medical care in a non-residential setting. The hospitals included in this

dissertation research are listed in Table 3. Psychiatric hospitalizations are defined as admissions

that occurred within short-term psychiatric hospitals with a Major Diagnostic Category (MDC)

code equal to '19-– Major Mental Diseases and Disorders.' In addition to the MDC criteria, the

study population also includes those patients with a billing for psychiatric inpatient services

(revenue code = 114, 124, 134, 144).

Table 3
Psychiatric Hospitals Included in Analysis of Study Population

Hospital Name	City	Adult Beds (2015)
Cascade Behavioral Health	Tukwila	18
Confluence Central Washington Hospital	Wenatchee	5
Fairfax Behavioral Health Kirkland	Kirkland	107
Fairfax Behavioral Health Everett	Everett	30
Harborview Medical Center	Seattle	61
Lourdes Counseling Center	Richland	23
Overlake Hospital Medical Center	Bellevue	14
PeaceHealth Saint John Medical Center	Longview	22
PeaceHealth Saint Joseph Hospital	Bellingham	20
PeaceHealth Southwest Medical Center	Vancouver	14
Providence Sacred Heart Medical Center	Spokane	28
Providence Saint Peter Hospital	Olympia	17
Saint Joseph Medical Center	Tacoma	23
Skagit Valley Hospital	Mt. Vernon	15
Swedish Medical Center - Cherry Hill	Seattle	10
Swedish Medical Center - Edmonds	Edmonds	23
University of Washington Medical Center	Seattle	14
West Seattle Psychiatric (Navos)	Seattle	40
Yakima Valley Memorial Hospital	Yakima	12

Adapted from "Crisis Mental Health Services and Inpatient Psychiatric Care: Capacity, Utilization, and Outcomes for Washington Adults," by M.H. Burley, 2016, Olympia, WA: Washington State Institute for Public Policy, p. 9.

Exclusion criteria. The study population excludes specific subgroups of psychiatric patients that are not present in community hospital discharge records. For example, patients treated at federal Veteran Administration (VA) hospitals and long-term state psychiatric hospitals are not represented in the study population. Federal and long-term psychiatric hospital patient populations may require specialized treatment and long-term intensive support that would not necessarily be consistent with the needs of patients seeking care at short-term psychiatric hospitals. While not the focus of this research, studies assessing the risk of psychiatric re-hospitalization have been completed for both Veteran populations (Bowersox, Saunders, & Berger, 2012) and patients treated in long-term psychiatric state hospitals (Thompson, Neighbors, Munday, & Trierweiler, 2003).

Two additional categories of patients are excluded from the study population. First, patients admitted to geropsychiatric hospitals are not considered in this analysis. In Washington State, three hospitals – Highline Medical Center/Cascade Behavioral Health, MultiCare Auburn Medical Center, and Northwest Hospital – specialize in psychiatric care for elderly patients. For geropsychiatric patients, post-discharge placements are more likely to include extended nursing home care, and inclusion of outcomes for these patients may bias results from an analysis of patients in a community setting (Morrow-Howell et al., 2006; Woo et al., 2006). Second, non-resident patients from a zip code outside a hospital referral region in Washington State are excluded. Study records are limited to Washington State hospitals and out-of-state patients with a recorded admission are more likely to return to a hospital not be included in the study dataset.

Data Collection

Secondary records used in this dissertation research is derived solely from the Comprehensive Hospital Abstract Reporting System (CHARS), a dataset collected and maintained by the Washington State DOH, Center for Health Statistics. According to the DOH, CHARS data are "used by policy makers, health professionals, community-based organizations, and researchers to understand trends, identify high risk populations, set prevention priorities, and plan targeted health promotion strategies" ("Hospital and Patient Data," 2016). Data are collected from billing systems in community hospitals throughout Washington State. The DOH provides research access to de-identified patient "revisit files" which can be used to track patient hospitalizations over a five-year time period. To maximize the available patient sample, linked patient files from three cohorts - 2009-2013, 2010-2014 and 2011-2015 – are included in the current analysis. Since the current analysis focuses on patients without a prior history of hospitalizations, there is not a risk that patient records will be duplicated across cohorts.

Human subjects' protection. For purposes of the current study, the CHARS inpatient limited files were obtained under a data sharing agreement with DOH. According to the Privacy Regulations issued under the Health Insurance Portability and Accountability Act (1996), limited datasets cannot include direct identifiers, such as name, social security numbers, or addresses. These patient datasets, however, may include some protected health information (PHI) such as patient zip code, admission date and detailed diagnosis and procedure codes. All investigators supporting this project understand and acknowledge identification of cases from this data is prohibited by the data sharing agreement. The collection and use of secondary discharge records for this dissertation research was determined exempt from full human subjects review by the Washington State University Institutional Review Board.

Variable measurement. The widespread use and verification of the CHARS records by payers, providers and policy-makers help ensure that these data offer a reliable and objective means for assessing psychiatric re-hospitalization. In addition, a number of programs and algorithms can be used to create valid risk indicators. These tools are centrally distributed through the AHRQ Healthcare Cost and Utilization Project (H-CUP) and include standardized definitions for clinical classifications, chronic conditions and comorbidity. These variables are described in further detail in the next section.

Variable Definitions

The present study tracks subsequent psychiatric hospitalizations following the index admission as the dependent variable of interest. For each countable hospitalization, patients must be admitted on an inpatient basis – observation, or outpatient visits will not be considered. Discharges coded as transfers, and admissions that occur on the day following the prior discharge are combined into the same hospital event.[3] Key independent variables are derived from the patient discharge record and include information about demographic characteristics, place of residence, diagnostic classifications, insurance status, and admission circumstances. Table 4 lists available variables with definitions.

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[3] Guidelines for determining readmissions for this dissertation research will follow criteria used for the H-CUPnet system. See Agency for Healthcare Research and Quality (AHRQ). (2016). *Methods - Calculating Readmissions for HCUPnet*. Retrieved from http://hcupnet.ahrq.gov/HCUPnet.app/Methods-HCUPnet%20readmissions.pdf.

Table 4
Independent Variables Included in Analysis

Category	Variable	Definition	Valid Values
Demographic	Sex	Patient gender identification	Male, Female
	Age	Age in years on admission	18 or older
	Race	Patient-identified racial preference	White, Black or African-American, American Indian or Alaska Native, Asian, Hawaiian or Other Pacific Islander, Unknown, Refused
	Hispanic	Patient-identified ethnicity	Hispanic (Yes, No)
Geographic	Urban Residence (patient zip code)	Based on 2010 Census Urban and Rural Classification (designated urban territory encompasses 2,500+ people)	Yes/No
	Patient Lives Outside Hospital Referral Region	Patients residential zip code is not within the Hospital Referral Region of index facility (based on Dartmouth Atlas of Health Care)	Yes/No
Diagnoses	Number of chronic conditions	Number of diagnoses (ICD-9) considered chronic according to H-CUP CCI	1-10
	Primary Diagnosis	Based on CCS codes 650-659	Anxiety/mood disorders, schizophrenia/psychosis
	Co-Occurring Personality Disorder	Based on CCS code 658 (secondary diagnosis)	Yes/No
Hospital Stay	Discharge status	Location identified on discharge order	Home (1), SNF (3), ICF (4), home care (6), left AMA (7), hospice (50), another facility type (61-95)
	Length of stay	Discharge date minus admission date	1-48
Financial	Primary Payer	Primary payer responsible for inpatient bill	Commercial (Private/HMO/Health Service Contractor), Medicaid, Medicare, Self-pay/Charity
	Dual-eligible	Entitled to Medicare (Part A or B) and Medicaid benefits	Based on primary and secondary payer codes

Note: ICD=International Classification of Disease; CCI= Chronic Condition Indicator; SNF= Skilled Nursing Facility; ICF=Intermediate Care Facility; CCS= clinical classification software

Analytical Plan

The following plan outlines the method and approach for assessing re-hospitalization outcomes in the identified study population.

Bivariate analyses. Bivariate statistics can be used to establish the direction and strength of relationships between key covariates and observed outcomes. In the case of longitudinal outcomes with censored data, the probability of event occurrence in each follow-up period can be illustrated with Kaplan-Meier (KM) curves. The KM curve provides a step-wise function that accounts for the serial time of each subject and the subject's status at the end of the observation period (event occurrence or censored) based on the number of subjects remaining in the risk set.

The Kaplan-Meier estimates can be compared between two or more groups to determine whether differences in survival probabilities are statistically significant. Two types of tests are common – the log rank test and Wilcoxon test. The log-rank test is based on a chi-square test of event occurrence for each event time, summed over the observation period for a final estimate (Rich et al., 2010). The Wilcoxon test is similar to the log-rank test, but includes a weighted estimate based on the size of the population in each observation period. Given a greater number of observations in earlier periods, the Wilcoxon test is more sensitive to differences in short-term survival probabilities, while the log-rank test provides a better indication of long-term differences. This dissertation research presents both tests of equality for survival probabilities of all covariates included in the final analytical model.

Multivariate analyses. A survival analysis for recurrent events is employed in this study to evaluate the stated hypotheses for this dissertation research. The analytical approach and assessment criteria is based on the two hypotheses stated earlier:

Primary hypothesis: overall risk and predictive factors for psychiatric re-hospitalization vary according to the temporal ordering of hospital episodes.

A typical survival model provides an adjusted estimate of the hazard rate – which simply represents the risk of failure relative to the probability of survival at each observed time period.[4] The hazard rate may only consider the first failure that occurs for each subject in the record set, and successive failures beyond the initial event are discarded. A survival analysis for recurrent events, on the other hand, utilizes all relevant information by including multiple records for each episode experienced by the subject. In this multiple-episode model, the first, second, and successive events are stratified and the hazard rates are modeled in each given strata.

A survival model for recurrent events can account for variation in baseline risk across episodes, improving the accuracy of standard errors and reliability of statistical inference. Obtaining precise and accurate measures of effects across episodes is important to the secondary stated hypothesis:

Secondary hypothesis: increased length of stay is associated with reduced re-hospitalization risk beyond the first admission.

This hypothesis suggests that the effect of treatment time may vary by hospitalization episode. Specifically, length of stay is invariant to re-hospitalization risk during the initial hospitalization, but related to reduced re-hospitalization risk in subsequent episodes. In a survival analysis for recurrent events, covariate effects can be modeled independently across each hospitalization episode.

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[4] For the remainder of this dissertation, the term 'risk' may be used to signify the hazard of event occurrence. When technical results are reported, the term 'hazard' or 'hazard rate' will be used.

Survival analysis assumptions. Two general classes of survival models are available to analyze risk of event occurrence over time. The first, parametric survival models, assume a known distribution of event times. The shape of the baseline hazard rate is fixed in parametric models, although the extent of this time dependency may be influenced by included covariates. In the second class of semi-parametric survival models, the distributional form of event times is not specified. Instead, the time dependency is parameterized in relation to the relative contribution of the covariates, rather than the intervals between duration times.

These semi-parametric models, also called Cox proportional hazard models, are more flexible since only the sequence, and not specific interval of event times, is important. However, there are key assumptions that must be satisfied using semi-parametric models. The proportional hazards assumption requires that the effect of the covariates must be consistent over time. As noted previously, studies on psychiatric re-hospitalization have found that the number of previous hospitalizations represents a key factor in predicting future risk. However, these studies assume that each prior hospitalization contributes equally to a patient's ongoing risk. Grambsch and Therneau (1994) devised a test for non-proportional hazards in Cox models based on the contribution to residual variance for each predictor variable in the model. The test evaluates the correlation between the scaled Schoenfeld residuals for each variable as a function of time and assesses if the distribution of failure times is uniform across each level of the predictor variable. The analysis for this dissertation research includes such a test to determine if prior hospitalizations and other available covariates contribute proportionally to the ongoing hazard of re-hospitalization. A violation of this assumption provides further justification to utilize a recurrent events survival analysis.

Recurrent events model potential biases. An analysis that examines multiple

hospitalizations per patient provides notable advantages over selecting a single, potentially

arbitrary hospitalization episode. However, this approach also introduces obvious event

dependence - the occurrence of a given episode makes future hospitalizations more likely. Three

of the most common methods for correcting for this dependence in a recurrent event analysis

include the independent increment, conditional elapsed-time and conditional gap-time models

(Box-Steffensmeier & De Boef, 2006). The Andersen and Gill-AG (1981) independent

increment model assumes that the occurrence of an event is unrelated to a prior event. Since the

baseline hazards for all events are common with the AG model, the parameter estimates are still

consistent, but standard errors are adjusted to account for multiple observations per subject. This

variance-corrected model is superior to the standard Cox regression model, but requires often

unrealistic assumptions about independence between events (Villegas, Julià, & Ocaña, 2013).

The Prentice, Williams and Petersen-PWP (1981) approach specifies that the risk of

subsequent events is conditional on prior occurrences. This conditional model uses stratification

to model the baseline hazard rate for each episode, with residual variance corrected according to

the specification of event times. Event times are specified as either elapsed (total time) or gap-

time, with the dependent variable 'reset' to zero after each event (see *Figure 5*). Conditional

elapsed time models are suitable when there is a theoretical risk of multiple events occurring

simultaneously, such as adverse childhood events within a sibling group (Wei & Glidden, 1997).

When risks develop *sequentially*, however, the conditional gap-time model is more appropriate.

For example, a model for re-hospitalization risk assumes that the risk for the second admission

would not occur until after the first hospital discharge occurs. In a simulation study, Kelly and

Lim (2000) found the conditional gap time superior for analysis of repeated events.
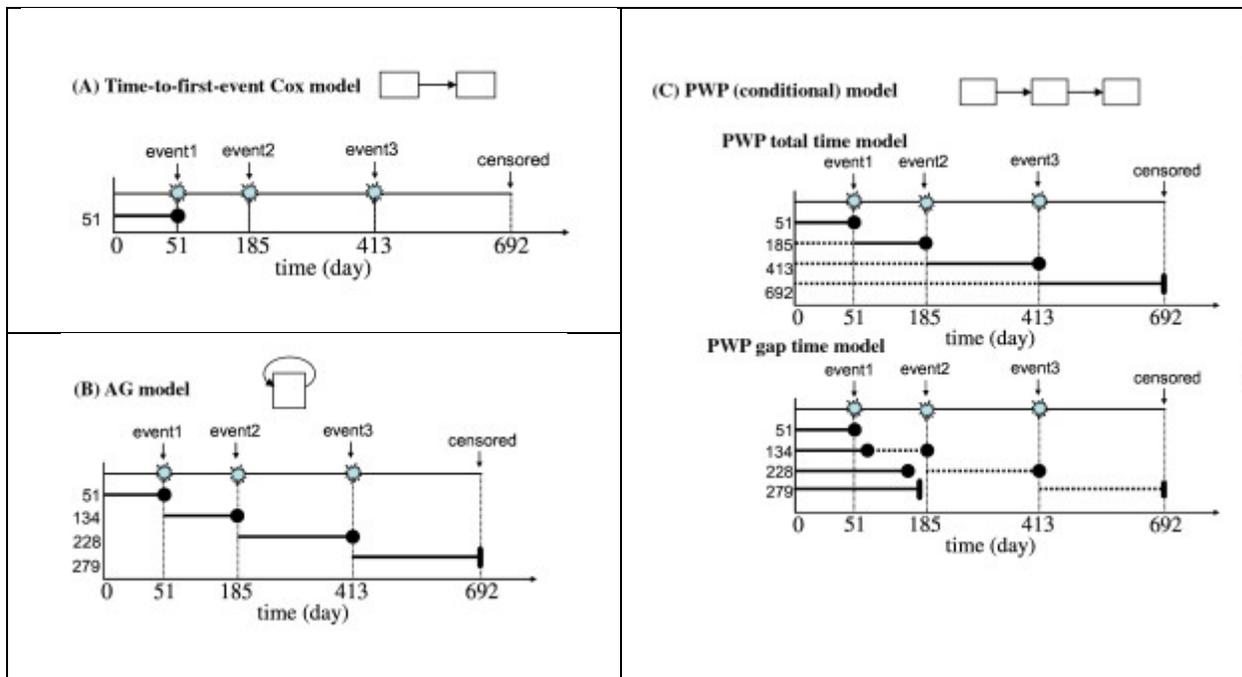
Figure 5. Diagram of Event Modeling for Extended Cox Regression Models
Note: Each arrow represents a stratum indicating successive events for a given individual.
Adapted from "Alternative statistical methods for estimating efficacy of interferon beta-1b for
multiple sclerosis clinical trials," by M.N. Mieno, T. Yamaguchi, and Y. Ohashi, 2011, *BMC
Medical Research Methodology*, 80, p. 3.

The second source of bias that may be present in a survival analysis for recurrent events

involves common variation between groups of individuals. For example, in the present

dissertation research, patients in a given hospital may have similar traits or exposure to treatment

that cannot be measured. Event history models that account for unobserved heterogeneity at the

group level are referred to as 'shared frailty' models, since observations within a subgroup may

be more failure prone, or likely to experience an event, than members of other subgroups

(Hougaard, 2000). The frailty term is a random effect that modifies the baseline hazard function

to account for between-group variation. This type of multi-level analysis has been relatively

unexplored in the literature on psychiatric re-hospitalizations. Leon, Stoner & Dickson (2015)

found that re-hospitalization risk did not vary significantly between hospitals in a multi-level

survival analysis of Medicaid-insured youth in Illinois. However, very few existing studies on

adult psychiatric re-hospitalization include multiple sites and none of the studies discussed in Chapter 2 used multi-level modeling. This dissertation research addresses both sources of bias – conditional event dependence and between-group variation – using the shared frailty model for recurrent events.

Power analysis. For purposes of statistical inference, a power analysis is necessary to determine the sample size required to detect a hypothesized effect size (Cohen, 1992). Power calculations for statistical tests depend on several factors including the null hypothesis to be tested, desired effect size, acceptable significance level and number of observations. In addition to the number of persons at-risk for experiencing an event, estimates of power for Cox proportional hazards are also based on the event rate. For this dissertation research, the rate of successive re-hospitalizations is a key factor in establishing the power to detect covariate effects.

In a longitudinal event history analysis, censored observations that do not experience an event (i.e. patient not re-hospitalized during study) do not contribute to available statistical power. The number of events (E) to attain a stated level of statistical power (1-β) at a given significance level (α) can be calculated using the following formula (Hsieh &Lavori, 2000):

$$E = \frac{(z_{1-\frac{\alpha}{k}} + z_{1-\beta})^2}{\sigma^2 \beta_1^2 (1 - R^2)}$$

In this formula, $z_{(1-\alpha/k)}$ and $z_{(1-\beta)}$ represent percentiles from a standard normal distribution for a one-sided (k=1) or two-sided test (k=2). The power of a statistical test to detect differences for a regression coefficient (β_1) is also dependent on the variance of covariate x (σ^2) and the correlation of x with other covariates in the model (1-R^2). For the Cox proportional hazards model utilized in this research, the regression coefficient β_1 can be stated as ln(Δ), the change in log hazards for a one-unit change in x.

To calculate a required sample size (*N*) for a Cox proportional hazard model, additional estimates on the probability of event occurrence are needed. (*p(E)*). For this dissertation research, patients are followed over multiple successive hospitalization events. For the purpose of a-priori power calculations, the probability of a re-hospitalization is estimated at 20% for the first event, 25% for the second and 30% for patients experiencing a third hospitalization. Table 5 shows the calculated sample size required to detect a small effect with 80% power at a statistical significance level of *p*=0.05 for each patient hospitalization event. Based on recommendations outlined in Olivier, May & Bell (2016), a hazard ratio of 1.22 or greater (or equivalent negative hazard ratio of 0.82 or less) can be considered a small relative effect. As Table 5 indicates, 794 events must be observed at the third re-hospitalization to achieve the desired 80% power. A total of 52,940 patients are required at the first hospitalization given the hypothesized event rate for each successive episode.

Table 5
Power Calculations by Hospitalization Episode

Hospitalization	Required N	Event Rate	Events	Available Power
Required Sample Size				
First	52,940	20%	10,588	100%
Second	10,588	25%	2,647	99%
Third	2,647	30%	794	80%
Estimated Sample Size				
First	46,000	20%	9,200	100%
Second	9,200	25%	2,300	100%
Third	2,300	30%	690	74%

*assumes two-sided hypothesis test at correlation=0 with additional covariates

A preliminary analysis of psychiatric hospitalizations based on 2013 data found that 11,545 adult patients in Washington State met the study inclusion criteria described above (Burley, Daratha, & McPherson, 2015). For this dissertation research, four cohorts of patients are planned (2012, 2013, 2014, 2015), comprising an estimated 46,000 patients. As Table 5 shows, with this number of patients, the first two hospitalizations will be sufficiently powered, but the third hospitalization is slightly under-powered to detect small effects.

As this example illustrates, a longitudinal study must include a sizeable number of patients to estimate the effect of risk factors on multiple re-hospitalizations. While such a sample is necessary to attain needed power for latter episodes, the large number of patients in the initial episode can also results in overpowered estimates. In such cases, very small differences can result in statistically significant effects, even if those associations are trivial. A danger arises when large sample sizes are used to prove or justify a desired effect based on statistical reasoning. For example, pharmaceutical companies may rely on larger trials with greater power to detect small differences that are statistically significant, but not meaningful or practical (Hochster, 2008). To guard against potential for large-sample bias, this dissertation research employs a bootstrapping re-sampling approach described in the next section, model assessment.

Model assessment. The practical application of any statistical model depends on the ability of that model to differentiate higher and lower risk subjects (discrimination) and predict observed behavior with reasonable accuracy (calibration). These two criteria, discrimination and calibration, provide a gauge of whether the model adequately fits the data and can be considered internally valid. Measures of discrimination in a survival analysis report on the ability of a model to distinguish events from non-events. The c-index represents the concordance between predicted probabilities and observed outcomes and falls between 0.5, for no predictive value (random

chance) and 1.0 for predicted values with perfect discrimination. The c-index commonly used for survival analysis tests the probability that for any pair of observations with an event and non-event, the predicted risk of an event is highest for the subject with the shortest survival time. However, since the occurrence of an event may depend on the available observation time for a subject, the c-index for a Cox model should also be adjusted for the censoring distribution of the study population. The c-index modified by Uno, et. al. (2011) divides the number of concordant pairs by comparable pairs and uses an inverse probability weight to adjust each pair comparison based on the likelihood that the two observations are not censored (Mauguen, Collette, Pignon, & Rondeau, 2013). The discriminatory ability of the current dissertation analysis is assessed based on Uno's adjusted c-index.

Internal validation addresses the problem of 'overfitting', or the tendency of a model to describe random patterns in the derivation data which obscure the true relationships of interest. This problem occurs because a model developed with a single sample may be tailored to that particular population, resulting in predictors that are unique to the underlying data and estimates that are inconsistent and biased. The accuracy of a model can be tested by analyzing multiple subsamples from the dataset and determining how predicted probabilities compare to observed outcomes, a process called bootstrap re-sampling. The sensitivity of the model concordance estimate derived in this dissertation research is tested by drawing 1,000 unrestricted random samples (with replacement) from the full dataset and calculating the 95% confidence interval for the resulting c-indices (Starr, 2013). All analyses related to model development and calibration are conducted using the SAS System for Windows, Version 9.4. A p value of less than .05 is considered to indicate statistical significance.

Chapter Four

Results

Introduction

The common approach to understanding the phenomena of psychiatric re-hospitalization typically involves an assessment of all patients (one-time hospitalized psychiatric patients as well as recurrently hospitalized psychiatric patients) discharged from psychiatric hospitals. In such traditional cross-sectional analyses, psychiatric patients with recurrent hospitalizations will be disproportionately represented, and may bias estimates of re-hospitalization risk. This dissertation research hypothesizes that factors related to psychiatric re-hospitalization should be evaluated sequentially – starting with the patient's initial hospitalization. By following patients over the course of successive inpatient episodes, this study aims to gain greater insight into the differentiation and development of risk factors over time. This chapter presents results from a survival analysis for recurrent events that follows hospitalization episodes over a two-year period after a patient's first psychiatric discharge.

Given the focus on the early development of re-hospitalization risk, the organization of this chapter proceeds in the following manner. First, a section on pre-screening the patient population is presented. The index hospitalization in this analysis occurs at the first observed admission during the two-year study window. This index hospitalization, however, may represent the first hospitalization for some patients and a re-hospitalization for other patients. Before discussing the characteristics of the study population, differences between patients with and without a history of psychiatric hospitalization are illustrated. The implications of including prior hospitalizations in statistical analyses are also discussed. Second, the characteristics of the

study population are described. Since the study population represents several patient cohorts (admitted between 2012 and 2015), patient entry into the analysis is explained.

The third section in this chapter illustrates re-hospitalization outcomes for the key covariates included in the analysis. Bivariate analysis results are presented as Kaplan-Meier survival curves that display the probability of the first observed re-hospitalization (survival) in the two years following the index discharge. The survival curves for each covariate category are compared statistically using a log-rank test that evaluates the null hypothesis of no differences in the probability of re-hospitalization among each group (Goel, Khanna & Kishore, 2010). The fourth section in this chapter covers the final multivariable survival analysis for recurrent events. Detail on the size and statistical power for each observed hospitalization episode is presented. For each recurrent episode, the effect of observed covariates for each successive episode are estimated. Finally, the results are internally validated using a bootstrap-resampling method to estimate variance in model prediction.

Prescreening Study Population

Identification of patients without a history of psychiatric hospitalization represents an important first-step to selecting the population of interest for this study. As outlined in the methods chapter, the hospital discharge records utilized for this analysis include a five-year history of patients hospitalized in Washington State. Linked patient records available for this study included three periods: 2009-13, 2010-14 and 2011-15. Patient records, however, are de-identified and can be matched within, but not across these three files (i.e. 2009 to 2015). Consequently, a discharge may appear in one or more of these linked datasets – patients discharged between 2011 and 2013 are included in each of the three files. To avoid crossover, and preserve a two-year follow-up time, the patient's first observed hospitalization in the year

prior to the end of the five year-period is selected. Table 6 shows the number of patients in each

group by discharge year.

Table 6
Patient Population Initial Selection – First Observed Hospitalization

Linked File Group	First Observed Discharge			
	2012	2013	2014	2015
2009-2013	10,026	-	-	-
2010-2014	-	9,441	-	-
2011-2015	-	-	9,482	8,168

A three-year hospitalization history is available for each patient group represented in

Table 6. Persons without any hospitalizations in the previous three years are considered patients

without a history of psychiatric hospitalization. Patients without a history of psychiatric

hospitalization are unduplicated and only appear in one cohort. Patients with prior psychiatric

hospitalizations would appear in one of the other linked patient groups (but could not be

identified). Such patients are removed from the study population to avoid any potential double

counting. The percentage of patients with and without a history of psychiatric hospitalization are

displayed in Table 7.

Table 7
First Observed Hospitalization by Prior Hospitalization History

Linked File Group	History of Psychiatric Hospitalization	First Observed Discharge			
		2012	2013	2014	2015
2009-2013	None	7,424 (74%)	-	-	-
	Previous History	2,602 (26%)	-	-	-
2010-2014	None	-	6,859 (73%)	-	-
	Previous History	-	2,582 (27%)	-	-
2011-2015	None	-	-	6,906 (73%)	6,668 (82%)
	Previous History	-	-	2,576 (27%)	1,500 (18%)

As Table 7 indicates, a point-in-time census of the psychiatric patient population is composed of approximately 75% patients with no history of psychiatric hospitalizations and 25% with a history of psychiatric hospitalizations. Patients with a history of psychiatric hospitalization have a re-hospitalization rate more than twice as high as patients without a history of psychiatric hospitalization, as shown in Table 8. While past psychiatric hospitalizations are clearly an indicator of future risk for subsequent psychiatric hospitalizations, including historical admissions as a re-hospitalization predictor remains problematic for two reasons. First, as demonstrated in Table 8, about half of all re-hospitalizations in each year occur among patients with a history of psychiatric hospitalizations. The development of factors associated with a re-hospitalization may be obscured if patients without a history of psychiatric hospitalization are analyzed alongside patients with a history of psychiatric hospitalization.

Table 8
Re-Hospitalization Rates by Cohort and Hospitalization Status

Discharge Year	Patients without a History of Psychiatric Hospitalization		Patients with a History of Psychiatric Hospitalization		All Patients	
	Re-Hospitalized (%)	Total	Re-Hospitalized (%)	Total	Re-Hospitalized (%)	Total
2012	1,265 (17%)	7,424	1,039 (39%)	2,602	2,304 (23%)	10,026
2013	1,131 (21%)	6,859	1,443 (44%)	2,582	2,574 (27%)	9,441
2014	1,516 (22%)	6,906	1,179 (46%)	2,576	2,695 (28%)	9,482
2015[a]	834 (13%)	6,668	354 (24%)	1,500	1,188 (15%)	8,168

[a] one-year maximum follow-up

Second, information about changes in risk factors over time may be lost without considering the order of hospitalizations. As discussed in the methods chapter, the proportional hazards assumption of a Cox regression model stipulates that the effect of a covariate does not change over time. In the case of re-hospitalized patients analyzed for this dissertation research,

we cannot assume that each prior hospitalization contributes in the same manner to ongoing risk.

Table 9 provides results for a test of the proportionality assumption of a model that includes patients with and without a history of psychiatric hospitalizations who were first discharged in 2014 or 2015 (see Appendix A). As Table 9 demonstrates, the hazard of re-hospitalization increases with each successive hospitalization and the null hypothesis that length of stay and previous psychiatric hospitalizations show no association with time is rejected in this model.

Table 9
Test of Non-Proportional Hazards for Single Episode Model

Predictor Variable	Correlation	t Value	p
Female	0.01	0.83	0.41
White Non-Hispanic	0.00	-0.27	0.79
Age (in decades)	0.00	0.31	0.76
Urban Residence	-0.01	-0.52	0.61
Admitted to Hospital Outside Home Hospital Referral Region	-0.01	-0.74	0.46
Discharged Home	0.04	2.76	<.01
Primary Diagnosis – Schizophrenia	0.01	0.83	0.41
Primary Diagnosis – Bipolar Disorder	0.01	0.65	0.50
Primary Diagnosis – Major Depressive Disorder	0.01	0.59	0.56
Co-Occurring Personality Disorder	0.01	0.40	0.69
Number of Chronic Conditions	-0.03	-1.56	0.12
Payer - Commercial	0.00	0.04	0.97
Payer - Medicaid	0.01	0.82	0.41
Payer – Dual Eligible	0.02	1.20	0.23
Length of Stay (Days)	0.06	3.61	<.01
Previous Psychiatric Hospitalizations	0.13	8.37	<.01

Note; based on patients discharged in 2014-15

To address violations of the proportional hazards assumption, the covariate in question can be interacted with time in the model. This approach, however, presumes that the associated hazard increases or decreases uniformly over time. Another option involves estimating a

stratified model which provides a different baseline hazard for each level of the covariate. Accordingly, a stratified recurrent events model is used for this study to calculate re-hospitalization risk following a patient's first, second and third psychiatric hospitalization.

This analysis proceeds by first selecting the 27,857 patients who did not have any psychiatric hospitalizations in the previous three years and experienced an initial psychiatric hospitalization between 2012 and 2015. Revisit files include five years of longitudinal data. Accordingly, patient outcomes are assessed for a maximum of two-years. Figure 6 illustrates the number of patients and available follow-up by discharge year. The remainder of this chapter describes the characteristics, risk factors and successive hospitalization outcomes for the combined 27,857 patients identified in this study without a history of psychiatric hospitalization.

Linked File Group	2009	2010	2011	2012	2013	2014	2015
2009-2013				7,424 new			
2010-2014					6,859 new		
2011-2015						6,906 new	
							6,668 new
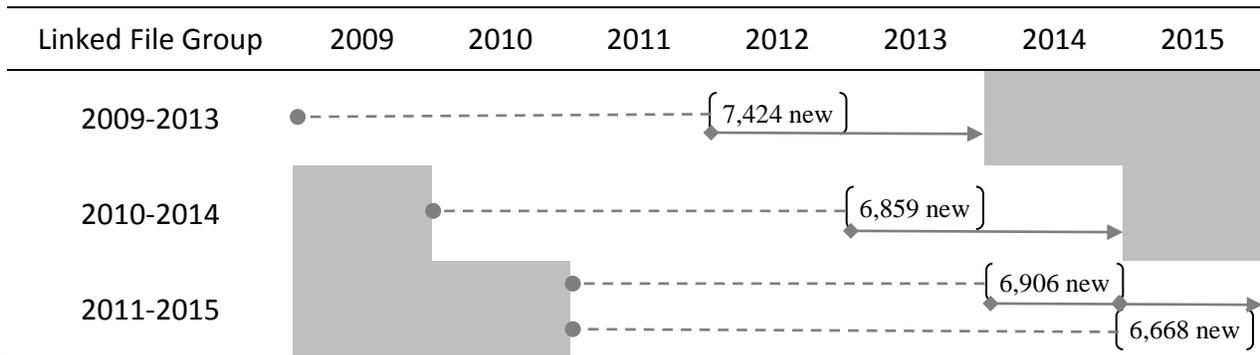
Figure 6. Patient Study Population by Cohort (n=27,857)

Study Population Description

The individuals in this study represent a demographically diverse cross-section of the psychiatric patient population. As described in Chapter 3, patient treated in geropsychiatric hospitals are excluded from this dissertation. Accordingly, patients over age 55 represent 17% of the study population. However, patients are distributed uniformly across remaining age categories, with each ten-year grouping representing approximately 20% of the study population

(Table 10). Patients are also equally represented by gender, with female patients constituting

52% of the study group. Nearly 8% of patient records did not include information about race or

ethnicity. Overall, White Non-Hispanics account for 76% of the study population and Black

Non-Hispanics constitute nearly 7%. Hispanics comprise 4% of all patients in the study. Finally,

87% of the patient population resides in an urban zip code and 21% live outside the referral

region of the admitting hospital.

Table 10
Study Population – Patient Characteristics

	Patients	
	n	(%)
Age		
18-25	5,895	(21.2)
26-35	6,211	(22.3)
36-45	5,362	(19.2)
46-55	5,546	(19.9)
56-65	3,325	(11.9)
over age 65	1,518	(5.4)
Gender		
Male	13,391	(48.1)
Female	14,466	(51.9)
Race/Ethnicity		
White, Non-Hispanic	21,193	(76.1)
Missing Race	2,212	(7.9)
Black, Non-Hispanic	1,908	(6.8)
Other Race	1,445	(5.2)
Hispanic	1,099	(3.9)
Urban Residence (Based on Patient Zip Code)	24,236	(87.0)
Patient Lives Outside Hospital Referral Region	5,851	(21.0)
Total	**27,857**	**(100.0)**

The primary diagnoses for patients in the study largely include three mental health

disorders (Table 11). Nearly half (45%) of adult patients have a primary depression diagnosis.

Another 46% of patients have a diagnosis of either schizophrenia (25%) or bipolar disorder

(21%). About one in ten patients (9%) have a co-occurring personality disorder. Physical health problems are also common among this patient population, with over half (54%) experiencing at least one chronic condition. Nearly one in five (19%) of psychiatric patients in the study have a diagnosis for three or more chronic physical conditions.

Table 11
Study Population – Clinical and Treatment Characteristics

	Patients	
	n	(%)
Primary Diagnosis		
Major depressive disorder	12,602	(45.2)
Schizophrenia and other psychotic	7,026	(25.2)
Mood-bipolar depression	5,823	(20.9)
Anxiety	1,037	(3.7)
Adjustment	903	(3.2)
Missing/Other Diagnosis	466	(1.7)
Co-Occurring Personality Disorder	2,563	(9.2)
Number of Chronic Physical Conditions		
no conditions	12,724	(45.7)
1 condition	6,099	(21.9)
2 conditions	3,877	(13.9)
3 or more conditions	5,157	(18.5)
Discharged Home	24,037	(86.3)
Primary Payer – Insurance		
Commercial	10,266	(36.9)
Medicaid	9,586	(34.4)
Dual Eligible (Medicare/Medicaid)	2,953	(10.6)
Self-Pay/Charity	2,707	(9.7)
Medicare	2,345	(8.4)
Length of Stay		
1-3 days	5,650	(20.3)
4-6 days	9,199	(33.0)
7-10 days	6,182	(22.2)
11-20 days	4,711	(16.9)
21 days or more	2,115	(7.6)
Total	**27,857**	**(100.0)**

The financial circumstances of patients and their length of time in treatment also varies across the study population. Patients having publicly-funded insurance represent over half of the study population with Medicaid (34%), Medicare (8%) and dual Medicare/Medicaid (11%) serving as the primary payer. Patients with commercial insurance constitute 37% of all patients, while 10% of patients are either uninsured or paid for hospital costs out-of-pocket. The length of the initial inpatient hospitalization differs substantially across included patients. While one-fifth of patients are hospitalized for three days or less, about 25% of patients have an initial hospitalization lasting 11 days or more.

Table 12
Study Population – Index Hospital by Hospital Referral Region

Hospital Referral Region	Index Hospital	Patients	
		n	(%)
Seattle	BHC Fairfax Hospital-Kirkland	5,117	(18.4)
	Overlake Hospital Medical Center	2,203	(7.9)
	Harborview Medical Center	1,905	(6.8)
	Navos	1,248	(4.5)
	Swedish Medical Center - Edmonds	1,177	(4.2)
	PeaceHealth Saint Joseph Hospital	1,100	(3.9)
	Swedish Medical Center - Cherry Hill	962	(3.5)
	University of Washington Medical Center	908	(3.3)
	Cascade Behavioral Health	316	(1.1)
Spokane	Providence Sacred Heart Medical Center	3,112	(11.2)
	Lourdes Counseling Center	1,263	(4.5)
	Confluence Health/Central WA	131	(0.5)
Tacoma	Saint Joseph Medical Center - Tacoma	2,867	(10.3)
Portland	PeaceHealth Saint John Medical Center - Longview	1,069	(3.8)
	PeaceHealth Southwest Medical Center	666	(2.4)
Olympia	Providence Saint Peter Hospital	1,695	(6.1)
Everett	Skagit Valley Hospital	840	(3.0)
	BHC Fairfax-Everett	370	(1.3)
Yakima	Yakima Valley Memorial Hospital	908	(3.3)
	Total	**27,857**	**(100.0)**

A large percentage of psychiatric hospitalizations are concentrated on the west side of the State of Washington (Table 12). Over half (54%) of the index hospitalizations among patients in the study population occur in facilities located in the Seattle Hospital Referral Region (HRR). Spokane is the second-most active HRR, representing 16% of all hospitalizations. Fairfax Hospital – a specialty psychiatric facility in Kirkland, WA has the highest number of patients, with over 5,000 admissions or 18% of the full study population. Statewide, re-hospitalizations outside the index hospital occur in 42% of all re-hospitalization events. Over half (53%) of the re-hospitalizations in the Seattle region take place in a facility other than the index hospital.

Bivariate Re-Hospitalization Outcomes

A bivariate analysis is included in this section to provide a preliminary assessment of the timing and rate of re-hospitalizations for different categories of patients. Table 13 presents both the log-rank and Wilcoxon test of differences for the survival probabilities by patient characteristics. As these results show, the largest bivariate differences in the probability of re-hospitalization were evident in the categories of primary patient diagnosis and type of payer.

Table 13
Tests of Equality for Probability of Re-Hospitalization

	Log-Rank	p	Wilcoxon	p
Primary Diagnosis	331.71	<0.01	298.00	<0.01
Primary Payer – Insurance	109.97	<0.01	96.62	<0.01
Age Group	17.65	<0.01	14.74	0.01
Patient Lives Outside Hospital Referral Region	14.63	<0.01	14.68	<0.01
Urban Residence	7.93	<0.01	6.80	<0.01
Co-occurring Personality Disorder	4.67	0.03	4.21	0.04
Gender	3.29	0.07	3.47	0.06
Number of Chronic Physical Conditions	2.38	0.50	2.03	0.57
Discharged Home	0.66	0.42	0.39	0.53
Race/Ethnicity	0.62	0.43	0.09	0.77

While statistically significant differences in the probability of re-hospitalization are also present for several demographic and geographic characteristics, the magnitude of the variation is considerably smaller. Figures 7 and 8 display the Kaplan-Meier curves by patient diagnosis and insurance payer - the two variables with the greatest divergence in re-hospitalization probabilities. Kaplan-Meier curves for other patient categories with statistically significant ($p<.05$) outcome probabilities are provided in Appendix B. These bivariate outcomes, however, only report on the time to the first observed re-hospitalization. The next section presents results for the multivariable recurrent event analysis that estimates associations for all observed covariates on the first, second and third re-hospitalization.
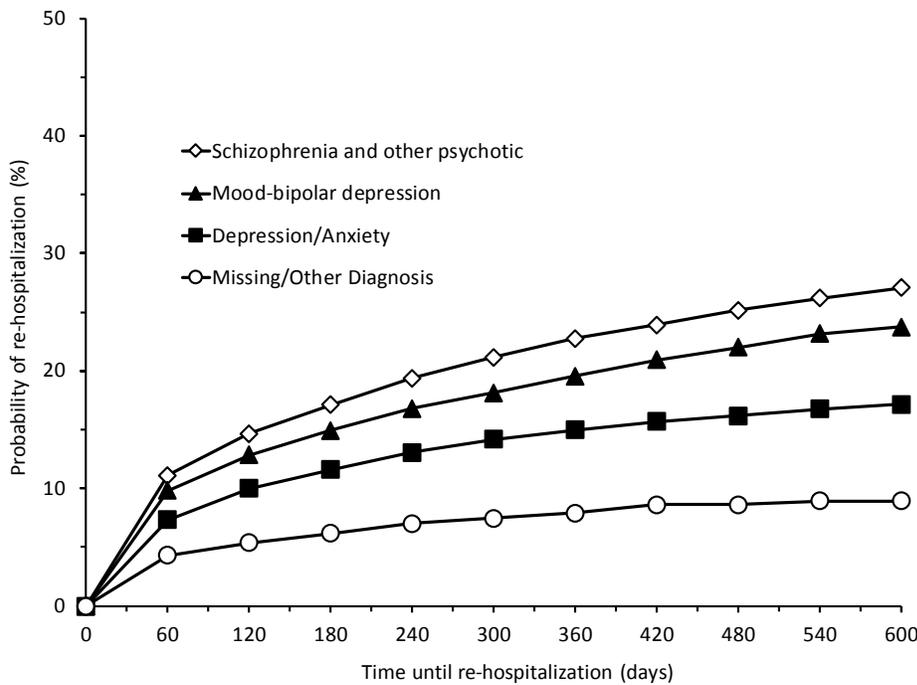

Figure 7. Kaplan-Meier Probabilities for Patient Re-Hospitalization by Primary Diagnosis
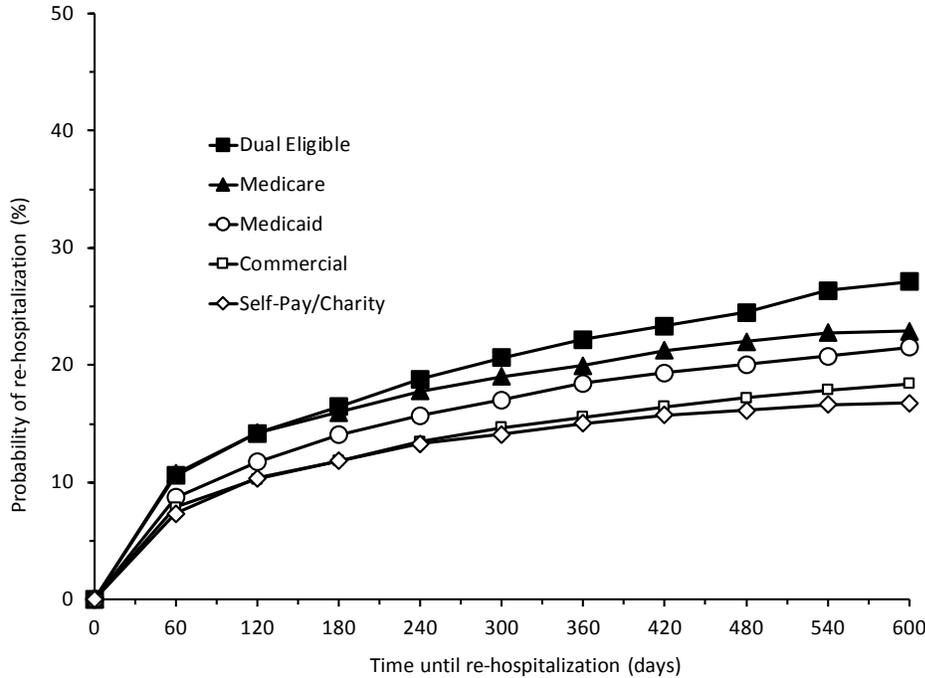
Figure 8. Kaplan-Meier Probabilities for Patient Re-Hospitalization by Primary Payer

Multivariable Survival Model for Recurrent Events

Study power. Among the 27,857 patients in the study that experienced their first

psychiatric hospitalization, 5,058 (18%) were re-hospitalized during the study period (Table 14).

After this first re-hospitalization, 1,478 of the remaining 5,058 patients (29%) were re-

hospitalized a second time. Finally, the re-hospitalization rate following the third hospital

discharge was 36% (534 of 1,478 patients).

Table 14
Re-Hospitalization Rate by Hospital Episode

Hospitalization Episode	Single Hospitalization		Re-Hospitalized		All	Expected Power to Detect Small Effects[a]
	n	(%)	n	(%)		
First	22,799	(81.8)	5,058	(18.2)	27,857	100%
Second	3,580	(70.8)	1,478	(29.2)	5,058	98%
Third	944	(63.9)	534	(36.1)	1,478	74%

[a] Assumes one-sided test to detect effect size (hazard ratio) of 0.82 or 1.22 and independence of covariate (inter-correlation=0)

While a sizeable number of patients are included in the study population, the attrition that occurs with each consecutive re-hospitalization reduces the number of observed events and available power for the analysis. The primary hypothesis of this dissertation research concerns differences in risk factors between the first and subsequent hospitalizations. A secondary hypothesis, however, suggests that increased inpatient treatment time may reduce the risk of re-hospitalization in later episodes. To detect any potential small effects related to this covariate, this analysis includes a power analysis for the available study sample using the formula developed by Hsieh & Lavori (2000). Results from this analysis are also presented in Table 14. Using these parameters, the present analysis appears adequately powered to detect small effects for the first and second hospitalization (100%, 98%). A lower number of events recorded for the third re-hospitalization results in a slightly underpowered analysis (74%) to detect small effects.

Recurrent event model results. The results from the multivariable survival analysis of recurrent events following a patient's initial psychiatric hospitalization indicate that when considering a patient's initial, or first psychiatric inpatient episode, several factors are associated with the risk of re-hospitalization (Table 15). After adjusting for other observed variables, a patient's primary diagnosis is found to be associated with an increased risk of re-hospitalization. Specifically, patients diagnosed with Schizophrenia have the highest hazard rate (HR=2.22, 95% CI [1.94, 2.54], p<.01), followed by Bipolar Disorder (HR=1.92, 95% CI [1.68, 2.20], p<.01) and Major Depressive Disorder (HR=1.40, 95% CI [1.23, 1.59], p<.01). A co-occurring personality disorder diagnosis is also associated with a 19% higher hazard of re-hospitalization (HR=1.19, 95% CI [1.09, 1.31], p<.01) following the first episode.

Table 15

Risk of Psychiatric Re-Hospitalization for Recurrent Events – Cox Proportional Hazards Model

	Episode 1		Episode 2		Episode 3	
	HR	95% C.I.	HR	95% C.I.	HR	95% C.I.
Female	1.12**	(1.06-1.19)	1.08	(0.97-1.20)	0.99	(0.83-1.18)
White-Non Hispanic	1.07	(1.00-1.14)	1.07	(0.94-1.21)	0.90	(0.74-1.09)
Age (in decades)	0.97**	(0.95-0.99)	0.96	(0.92-1.00)	0.97	(0.91-1.04)
Urban Residence	1.05	(0.96-1.15)	1.29**	(1.09-1.54)	0.83	(0.63-1.09)
Admitted to Hospital Outside Home Hospital Referral Region	0.84**	(0.79-0.91)	0.97	(0.86-1.11)	0.84	(0.68-1.04)
Discharged Home	1.12*	(1.03-1.22)	1.08	(0.94-1.25)	1.07	(0.83-1.38)
Primary Diagnosis-Schizophrenia	2.22**	(1.94-2.54)	1.38*	(1.04-1.84)	1.22	(0.77-1.94)
Primary Diagnosis-Bipolar Disorder	1.92**	(1.68-2.20)	1.14	(0.86-1.51)	1.14	(0.72-1.81)
Primary Diagnosis-Major Depressive Disorder	1.40**	(1.23-1.59)	1.22	(0.93-1.61)	1.02	(0.65-1.61)
Co-Occurring Personality Disorder	1.19**	(1.09-1.31)	1.02	(0.87-1.20)	1.28*	(1.01-1.63)
Number of Chronic Conditions	1.01	(0.99-1.04)	1.04*	(1.00-1.08)	1.03	(0.97-1.09)
Payer - Commercial	0.86**	(0.79-0.93)	0.99	(0.84-1.17)	1.01	(0.75-1.35)
Payer - Medicaid	0.95	(0.88-1.04)	1.05	(0.89-1.23)	1.02	(0.77-1.36)
Payer - Dual Eligible	1.15*	(1.04-1.27)	1.09	(0.90-1.32)	1.15	(0.84-1.58)
Length of Stay (Days)	1.00*	(1.00-1.01)	0.99*	(0.99-1.00)	0.99*	(0.98-1.00)

* $p < .05$ ** $p < .01$ Likelihood Ratio = 588.5544 (50.51, p<.0001)   n=34,393

Table 16

Risk of Psychiatric Re-Hospitalization for Recurrent Events – Random Effects

Hospital Referral Region	Lognormal frailty estimate	95% C.I.
Everett	1.15	(0.98-1.35)
Olympia	0.94	(0.81-1.10)
Portland	1.05	(0.90-1.22)
Seattle	1.18	(1.03-1.35)
Spokane	0.87	(0.75-1.00)
Tacoma	1.12	(0.97-1.29)
Yakima	0.76	(0.64-0.91)

frailty variance parameter = 0.029, variance parameter estimator standard error=0.018

Financial indicators exhibit a contrasting relationship with the risk of first re-hospitalization. While patients with commercial insurance have a 14% decreased hazard rate (HR=0.86, 95% CI [0.79, 0.93], p<.01), the re-hospitalization hazard rate is 15% higher (HR=1.15, 95% CI [1.04, 1.27], p<.01) for dually eligible (Medicare/Medicaid) patients. Demographic factors demonstrate a smaller, but statistically significant, relationship with re-hospitalization risk following the first psychiatric hospitalization. While race and ethnicity are not associated with re-hospitalization, every ten-year increase in patient age is related to decreasing re-hospitalization risk of 3% (HR=0.97, 95% CI [0.95, 0.99], p=.01). Finally, female patients have a 12% elevated hazard rate (HR=1.12, 95% CI [1.06, 1.19], p<.01) following the first episode.

While the recurrent event model identified clinical, financial, and demographic variables that are predictive of a patient's first re-hospitalization, these same factors do not reflect risk of re-hospitalization in latter episodes. During a patient's second psychiatric hospitalization, only two variables have a moderate effect on re-hospitalization. The hazard rate for patients with a primary Schizophrenia diagnosis is 1.38 (95% CI [1.04, 1.84], p=.03) for the second hospitalization. After controlling for other factors, patients living in urban locations also have an increased hazard of a second re-hospitalization (HR=1.29, 95% CI [1.09, 1.54], p<.01).

In both the second and third hospital episode, the length of stay is associated with a statistically significant reduced hazard of re-hospitalization. For each additional day of inpatient treatment, a patient's hazard of re-hospitalization decreases by 1% for the second (HR=0.99, 95% CI [0.99, 1.00], p=.01) and third (HR=0.99, 95% CI [0.98, 1.00], p=.03) episode. While this observed effect is small, length of stay represents the only variable with statistically significant effects on re-hospitalization for later episodes.

This recurrent event model also accounts for geographical clustering of patients. The random effects control for unobserved heterogeneity within hospital referral regions that may share common community resources and treatment approaches. Survival models with both fixed and random effects are referred to as shared frailty models (Vaupel, Manton & Stallard, 1979). These models correct for potential correlation of failure times within groups of subjects. In the model presented in Table 16, patients in the Seattle HRR are re-hospitalized at a higher rate than under the independence model, while patients in Spokane and Yakima HRR experience a lower relative re-hospitalization rate. However, the small frailty variance parameter (frailty variance parameter/REML=0.029, se =0.018) suggests a minor level of between-cluster heterogeneity. Consequently, this dissertation research focuses on the effect of patient-level factors on re-hospitalization over time.

Model assessment and validation. The recurrent event model for re-hospitalization risk presented for this dissertation research exhibits a high level of discrimination, based on Uno's concordance statistic (c-statistic). While there are no universal standards on assessing the predictive strength of a model, a c-statistic above 0.7 generally indicates acceptable discrimination, values above 0.8 show excellent discrimination, and values at or above 0.9 provide outstanding discrimination (Rice & Harris, 2005; Hosmer, 2013). The c-statistics for the first three psychiatric hospitalization episodes of the study population all exceed the 0.8 threshold (Table 17). While the predictive accuracy is higher for the second and third hospitalization, patients observed during these episodes already have a previous hospitalization. At the first episode, however, patients do not yet have a known history of previous psychiatric hospitalizations. The variables included in this recurrent events model still provide an excellent level of discrimination for patients at high risk for their first psychiatric re-hospitalization.

Table 17
Recurrent Event Model Concordance Statistics

Hospitalization Episode	Uno's c-statistic	95% bootstrapped C.I. for c
First	0.805	(0.796-0.814)
Second	0.893	(0.880-0.904)
Third	0.865	(0.837-0.892)

Note: Results based on 1,000 bootstrapped samples (uniform replacement sampling)

The final step in assessing the adequacy of the recurrent events model includes an internal validation process based on the perturbation resampling technique specified by Uno, Cai, Pencina, D.Agostino & Wei (2011). The 95% confidence interval for the c-statistic drawn from these bootstrapped samples is also provided in Table 17. The results from this validation show a narrow range in the bootstrapped standard error – particularly for the first and second episodes - indicating a high level of confidence in model discrimination. The implication of this approach for the early prognosis of psychiatric re-hospitalization risk is discussed in the next chapter.

Chapter Five

Discussion

Summary

The psychiatric hospital provides a vital treatment setting for patients experiencing unmanageable and potentially dangerous symptoms of serious mental illness. Despite an inherent need for inpatient treatment on the care continuum, the number of available psychiatric hospital beds in the United States plummeted from about 500,000 in the 1960's to approximately 50,000 today - about half the number some experts believe is necessary to meet current treatment needs (Satel & Torrey, 2006). This purposeful dismantling occurred with the expressed goal of moving patients from abysmal care in state psychiatric hospitals to a comprehensive system of community-based outpatient care. Unfortunately, services in the community have failed to meet the treatment needs of selected patients with serious and persistent mental illness. The resulting deficit of intensive therapeutic care has left psychiatric patients at a higher risk of homelessness (Yohanna 2013), incarceration (Lamb 2015), or suicide (Bastiampillai, Sharfstein & Allison, 2016).

The legacy of the post-deinstitutionalization era involves a replacement of substandard institutional treatment in favor of a disjointed system marked by repeated hospitalizations and emergency department stays (Swartz 2016). The underlying problem with our current approach to inpatient mental health care is noted by Lamb & Weinberger (2016):

A major obstacle to understanding and addressing the problems of deinstitutionalization

has been a failure to recognize that persons with serious mental illness are a

heterogeneous group who vary greatly in their capacity for rehabilitation. (p. 109)

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This dissertation research addresses the foundational issue that must precede any meaningful transformation of mental health care in the United States – the early identification of persons at high risk for treatment failure. If such patients can be identified, integrated care and other therapeutic solutions can be tested to determine which approaches are effective in reducing the risk of ongoing psychiatric hospitalizations.

Although scholars have studied the potential causes and correlates of psychiatric re-hospitalization for decades, the existing body of evidence has yet to establish a consistent and reliable set of indicators for identifying high-risk patients (Klinkenberg & Calsyn, 1996; Montgomery and Kirkpatrick 2002; Sledge & Dun, 2009; Gerolamo, 2014). Two principal gaps in the available research have precluded a clear understanding of potential predictors. First, current studies rarely account for the initiation or progression of acute psychiatric episodes. Instead, studies typically control for the number of previous psychiatric hospitalizations. But this approach does not recognize that risk factors and therapeutic approaches may change over time and impede a focus on the early identification of relapse signs. Second, the relative difficulty of following a large patient sample over an extended period of time has also hindered previous research efforts. To assess risk from a longitudinal perspective, the study sample must include sufficient numbers of subjects to detect statistically meaningful differences among patients that may experience repeated hospitalizations.

The unique contribution of this dissertation research starts with the utilization of statewide linked administrative discharge records that follow patient hospitalizations over five years. The study cohort includes patients without a recent history of psychiatric hospitalizations, establishing the potential onset of a re-hospitalization cycle. While previous research in this area assessed the risk of a single re-hospitalization, the novel approach employed in this study

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includes an examination of re-hospitalization risk over multiple episodes of care. Three main findings emerged from this longitudinal recurrent event history analysis. 1) a large-scale, multi-site sample is necessary to evaluate psychiatric re-hospitalization; in this study, 42% of observed re-hospitalizations occurred in a facility other than the index hospital; 2) clinical diagnoses, financial circumstances, and patient demographic characteristics provided strong predictive ability for the time to first re-hospitalization; and 3) there are few differentiating factors for subsequent re-hospitalizations, although urban patients with schizophrenia show a higher likelihood of experiencing multiple episodes. Additional information about the study population and findings are presented in the next section.

Discussion of Findings

The results from this dissertation research point to several conclusions that confirm previous work on this topic and suggest a direction for ongoing research regarding psychiatric patient outcomes. This section details three aspects of the work that address key questions related to psychiatric re-hospitalization. First, it is instructive to examine the dynamics of patient flow in and out of psychiatric hospital facilities. To the extent that early identification is necessary to reduce the likelihood of recurrence, it is vital to know **how many** first-time patients might go on to develop a pattern of repeated hospitalizations. Second, to target transitional resources effectively, it is also critical to understand **which** patients are at risk of a first re-hospitalization. Finally, assisting psychiatric patients that are currently in a pattern of repeated hospitalizations requires a clearer understanding of **what** risk factors apply to repeat patients and whether extended inpatient treatment can be beneficial for these patients.

As noted in the literature review, studies on psychiatric hospitalization typically involve a patient population selected at a given point in time – effectively intermingling one-time patients

that will never return to the hospital with patients that are currently or will eventually experience a series of re-hospitalizations. In the pre-screening stage of this dissertation research, about 27% of the patients selected at the first observed psychiatric hospitalization during the study year had a recorded history of prior hospital admissions. The study with the longest follow-up in this dissertation literature review, that followed patients over a seven year period, also found that 25% of psychiatric patients observed during this time had multiple re-hospitalizations (Hudson 2005). The mixture of patients from a low risk subpopulation with patients from a high risk subpopulation creates a positive duration dependency (Rohwer & Blossfeld, 2001), where the overall risk of re-hospitalization are increasing over time given that high-risk patients are more likely to remain in the risk set. Similar to long-term studies conducted in other countries (Kessing, Andersen, & Mortensen, 1999; Kessing & Andersen, 2005), this dissertation research demonstrates that when patient episodes are followed sequentially over a two year period, the risk of recurrence increases with each episode.

The principal objective of this dissertation research is to detect potential precursors to treatment failure to prevent patterns of re-hospitalization from developing. The analysis presented here includes approximately 10,000 adult psychiatric patients with an inpatient admission in a given year. Approximately three out of four of these patients are without a recent history of hospitalizations and likely unknown to hospital staff. Among these first-time patients, between 1,000 and 1,500 (10%-15% of the annual cohort) will experience additional hospitalizations in the two years following discharge. To intervene prior to the initiation of a cycle of recurrent hospitalizations, it is necessary to know more about the entire population of first-time psychiatric patients and understand who is at risk of return following the initial discharge.

Psychiatric patients included in this study represented a diverse range of individuals, similar in many ways to the population of the state-as-a-whole. As the results section indicates, the study population is roughly split evenly between males (48%) and females (52%) and distributed uniformly across each age group (age 18-55). Slightly more than three-quarters (76%) of the study group is comprised of non-Hispanic Whites, similar to a 74% statewide percentage of Caucasian adults in Washington State (Washington State Office of Financial Management, 2016). On the other hand, non-Hispanic Blacks (7%) were overrepresented compared to the statewide adult population (3%), consistent with national estimates showing a higher rate of inpatient mental health service use among Black or African-American adults with serious mental illness (SAMHSA, 2015). In contrast, the 4% Hispanic population in this study is much lower than the statewide population of Hispanic adults (10%) which may reflect a lower overall mental health treatment rate among Hispanic Americans (United States Center for Mental Health Services, 2001). With few exceptions, however, the study population encompasses a broad demographic cross-section and illustrates that strategies to address psychiatric re-hospitalizations must consider the diversity among persons requiring inpatient psychiatric care.

The two strongest predictors of psychiatric re-hospitalization among patients without a previous history of hospital admissions include clinical diagnoses and insurance status. The highest adjusted hazard of re-hospitalization occurs among patients with a primary diagnosis of schizophrenia or psychosis (HR=2.22), followed by diagnoses for bipolar (HR=1.92) and major depressive disorder (HR=1.42). Patients with a co-occurring personality disorder diagnosis also have a 19% higher adjusted risk of re-hospitalization. While there are indications that conditions such as borderline personality disorder may go undiagnosed in clinical hospital records (Comtois & Carmel, 2016), secondary personality disorders may provide an important indicator for

assessing a patients capacity for therapeutic engagement and adherence to prescribed pharmacologic and psychosocial-oriented treatments. Finally, in this analysis, patients with commercial insurance status experience a 14% reduced risk while dually eligible Medicare/Medicaid patients have a 15% higher risk of re-hospitalization. Compared to other beneficiaries, dual-eligible patients typically experience poorer health or disability and this finding may be related to functional capacity of patients rather than financial circumstances. While limited information about the functional domain of patients was available for this study, the dynamic between health coverage and other types of support deserve further consideration in future research.

Patient demographics also provide a marker of potential risk for psychiatric re-hospitalization among patients without a recent hospital admission. While race or ethnicity did not indicate an association with re-hospitalization, a patient's gender and age are significantly related to the risk of repeated hospital admissions. Female patients without a recent history of psychiatric hospitalizations have a 12% increased risk of subsequent hospitalization. In the fully-adjusted model, each ten-year increase in patient age is associated with a 3% decline in re-hospitalization risk. It bears mentioning that these results apply exclusively to the study population – patients without a previous history of psychiatric hospitalizations. In the comparison model that includes patients *with* a history of previous hospitalizations (Appendix A) demographic factors did not demonstrate a statistically significant relationship with psychiatric re-hospitalization risk. The contrasting effect of demographic variables in these two models illustrates the importance of considering early predictors of risk in the assessment of psychiatric re-hospitalization.

While the detection of an early risk profile for psychiatric re-hospitalization forms the rationale for this analysis, the differentiation of risk factors over time also serves as the primary hypothesis for the dissertation research. Two aspects of the recurrent event model employed here bear further consideration. Based on the analysis results, the null hypothesis that risk factors for subsequent hospitalizations are not related to the timing and succession of hospital episodes is rejected. Only three characteristics of patients remaining in the study cohort after the first or second psychiatric hospitalization predicted re-hospitalization outcomes. Patients living in urban areas, patients with comorbid chronic conditions and those with a diagnosis of schizophrenia or psychosis have a higher risk re-hospitalization following the second episode. This finding is consistent with a matched cohort study of 150 patients with a without recurrent psychiatric hospitalizations. This study by Schmutte et al. (2009) found that presence of a psychotic disorder and lack of employment were the only two factors associated with high inpatient utilization over a 48-month period.

Given the relative lack of distinct risk factors beyond the first re-hospitalization, it appears necessary to consider that all patients with an established history of re-hospitalization face an ongoing risk of return with each subsequent hospitalization. An additional hypothesis for this dissertation research focuses on modifiable factors that might influence continuing re-hospitalization risk. The secondary alternative hypothesis posited that increased length of stay is associated with reduced re-hospitalization risk beyond the first admission. During the second and third psychiatric hospitalization, each additional day of inpatient treatment did show an adjusted 1% reduction in re-hospitalization risk. While this statistically significant effect is small, the consistency of the effect across episodes points to further validation and research. One

suggestion might include a randomized controlled trial where the effect of varied treatment time is tested on outcomes for psychiatric patients with a known history of hospitalizations.

Implications for Practice

From a practical standpoint, this dissertation research seeks to pinpoint the unique factors that influence psychiatric re-hospitalization. The theoretical framework presented in the methods chapter proposes grouping these factors into domains reflecting client vulnerabilities, community support, system responsiveness and receipt of aftercare provided. Data available for this analysis focus solely on patient-level discharge records. The effect of aftercare treatment, family or social support networks, and medical treatment of comorbid chronic conditions could not be adequately evaluated. However, this dissertation research did include outcomes for patients admitted to 19 different hospitals operating in seven distinct hospital referral regions. The resulting analysis indicates that very little variation in re-hospitalization outcomes occurs at the system-level, even after controlling for patient-level differences. These findings suggest that strategies to reduce the burden of psychiatric re-hospitalization should focus primarily on patient-oriented assessment and intervention, rather than administrative or organizational changes.

One obvious extension of this dissertation research involves the development, testing and adoption of risk assessment instrument to identify patients at high-risk of psychiatric re-hospitalization. Risk and needs assessment instruments are used across a variety of settings to classify individual, target treatment approaches, monitor performance and reduce costs. Validated instruments can aid in decision-making regarding need for alcohol and drug treatment, preventing high school dropouts, reducing intimate partner violence and criminal sentencing alternatives based on likelihood of re-offense. Risk assessment instruments are also becoming more widely utilized in hospital discharge planning to prevent readmission following medical

discharge (Zhou, Della, Roberts, Goh, & Dhaliwal, 2016). Standardized information from validated instruments can help ensure that the appropriate levels of discharge care are provided, improving patient outcomes across psychiatric hospitals and reducing costs associated with unnecessary readmissions.

Across all diagnostic categories, the highest re-hospitalization rates in the United States occur among patients with mental health conditions such as schizophrenia or major depressive disorder (Trudnak et al., 2014; Hines et al., 2006). Given the recognized shortage of mental health treatment resources, there is a clear need to develop a valid and reliable predictive instrument to align intensive interventions to patients with the highest need. The READMIT index developed by Vigod et al. (2015) represents the first published effort to quantify and scale psychiatric re-hospitalization risk based on information commonly available at discharge. This index provides a score for 30-day readmission risk based on Repeat lifetime admissions, Emergent admissions, Age, Diagnosis, Medical comorbidity, Intensity of recent service use and Time in hospital. The READMIT index was tested and validated for patients admitted to psychiatric hospitals in Ontario, Canada. However, this research demonstrates the rationale for classifying patient risk and provides the necessary foundation for designing a similar risk assessment instrument based on a psychiatric patient population in the United States.

A validated and standardized screening instrument can serve as an effective tool in identifying patients that might benefit from comprehensive support across piloted and tested interventions. The multivariable model presented in this research exhibited excellent performance in predicting probability of first re-hospitalization for patients without a recent history of psychiatric hospitalizations. However, post-discharge screening and assessment only represents the first step in addressing the re-hospitalization problem. As noted in the literature

review chapter, there are few evidence-based interventions for patients discharged from inpatient psychiatric care (Gaynes et al., 2015). One reason for the lack of an evidence base on transitional care stems from the absence of a tailored and targeted approach that can reach subpopulations at the highest risk of re-hospitalization (Viggiano, Pincus, & Crystal, 2012). As Cuffel et al. (2002) conclude, the efficient delivery of outpatient care to selected patients may prove more effective in reducing hospital returns than changing the amount or type of care provided to all patients following psychiatric discharge.

From a broader perspective, this dissertation research contributes to existing work that demonstrates the benefit of utilizing longitudinal datasets in mental health services research. Perhaps the most notable long-term studies in this area come from the Danish National Patient Registry (DNPR). The DNPR includes population-wide data for over 8 million citizens admitted to hospitals in Denmark in 1977 or later (Schmidt et al. 2015). The ability to track patient outcomes over several decades permits an unprecedented examination of the initiation and progression of psychiatric disorders such as schizophrenia. For example, Olesen and Parner (2006) used the DNPR to examine psychiatric hospitalization patterns of nearly 9,000 patients in Denmark over an 18-year period. Similar to this research, the Danish study found that sequence of hospital episode is determinative of the probability and timing of re-hospitalization.

While such an extended psychiatric patient registry data is not available in the United States, this dissertation research shows the advantage of employing statewide 'revisit' files for a similar studies of patient outcomes. Before these findings can be applied in a clinical setting, however, the model should be externally validated. Fortunately, six additional states – Arkansas, Florida, Massachusetts, Nebraska, New York, and Utah – also maintain hospital revisit files that include five or more years of linked inpatient records (Healthcare Cost and Utilization Project,

2017). While there are both strengths and limitations to this statewide revisit data, a multi-state analysis with standardized records of a highly diverse patient population could be used to establish the consistency and precision of these state-specific findings.

Limitations and Strengths

This dissertation research incorporates a unique approach to investigating re-hospitalization dynamics by leveraging a large publicly-available administrative database to follow a statewide population of psychiatric patients over time. While there are notable advantages to the research design employed here, there are also drawbacks to this approach that should be stated as well. These limitations involve the size, specificity, and scope of the data utilized in this analysis. While these limitations should be acknowledged, it is important to note that any considerable research effort faces a series of tradeoffs in carrying out the objectives of the study. Recognizing the shortcomings of a study also provides an opportunity to build on established findings, develop or refine innovative methods and advance knowledge in the field.

The longitudinal analysis presented in this research follows over 27,000 adult patients across a statewide network of hospitals. The large study population provides ample power to detect statistically significant differences associated with the first or second re-hospitalization. However, given the two-year follow-up, only 2% of the initial cohort (n=534) have a third re-hospitalization during the observation period. The small number of patients remaining in the study with successive hospital episodes limits the ability to identify significant differences among the highest risk patients. As demonstrated in the literature review chapter, the study population used for this analysis surpasses the sample size in nearly all other related research. This initial effort demonstrates the feasibility of using statewide revisit files and provides a basis for further work using these data. Using hospital revisit data from other states or adding new

patient cohorts from Washington State are two options that could increase sample size and improve statistical power to identify factors associated with multiple hospitalization episodes.

The CHARS revisit data provide a reliable source of information for a geographically diverse, all-payer patient population. While these data are a valuable resource for research, the primary purpose of these records are for utilization monitoring and billing. As such, risk factors other than the ones examined in this dissertation research may account for important sources of variance that contribute to the prediction of recurrent hospitalization. A patient's level of functioning, for example, is not included in discharge records. Functional capacity could provide an assessment of disease severity and indicate the amount and type of supports necessary for the patient to live independently following discharge. Likewise, level of family and social supports represents a likely indicator of risk unavailable in these data. While some states include marital status on the discharge record, this information is not available for discharge records in Washington State. Additional detail about family circumstances and involvement could prove important for testing and adopting treatment approaches for patients with an established support network in place.

In addition to community support, receipt of aftercare is another key indicator for understanding risk of recurrent psychiatric re-hospitalization. Unfortunately, the records available for this dissertation research only encompass information associated with the inpatient hospital stay. The extent to which a patient is able to access treatment providers in the community and engage in outpatient mental health treatment is not included in hospital records. Additionally, post-discharge events such as emergency department visits and jail bookings or arrests are not included in this analysis. The purpose of this dissertation research, however, is not to examine the multitude of intervening events for recurrent patients, but to differentiate early

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indicators of psychiatric re-hospitalization risk. The results presented here establish a useful set of demographic, clinical and financial indicators that can serve as a platform to developing a more comprehensive assessment of risk and testing the effectiveness of post-discharge interventions.

Conclusion

In 1963, President Kennedy called for a bold new approach in the treatment and care of individuals with serious mental illness. The passage of Kennedy's final piece of legislation – the Community Mental Health Act – promised to transform the ill-equipped and inhumane system of institutional care to a network of comprehensive community based care centers. This community-based approach was meant to provide the patient with "a better understanding of his needs, a more cordial atmosphere for his recovery and a continuum of treatment." (Kennedy, 1963). Over fifty years later, this vision has yet to be realized. While community-based treatment may be responsive to the needs of persons with less serious mental health conditions, effective and targeted treatment interventions have not been widely adopted for patients with serious and persistent mental illnesses. As Teich (2016) notes, "In a world where both policy and medicine are increasingly expected to be 'evidence-based', the evidentiary basis for addressing SMI in the United States in disturbingly weak." (p. 67).

A substantial number of prior studies on psychiatric re-hospitalization identify prior hospitalizations as the prime indicator of future re-hospitalization risk. This dissertation research, on the other hand, focuses on persons *without* a recent hospitalization history in order to evaluate factors associated with the initiation and progression of risk over time. The resulting multivariable model provides a valid set of demographic, clinical and economic indicators that could be used to differentiate first-time psychiatric patients with a high probability of re-

hospitalization. This approach emphasizes the feasibility and value of assessing psychiatric re-hospitalization risk before a pattern of recurrent admissions begins. Early assessment and intervention may also be critical to improving treatment outcomes for patients as well. For example, the multisite Recovery After an Initial Schizophrenia Episode (RAISE) study tested the delivery of coordinated specialty care (CSC)[5] for young adults experiencing first-episode psychosis. Compared to usual care, CSC participants in this cluster-randomized trial had higher outpatient treatment engagement, greater symptom reduction and increased involvement in school or work (Kane et al, 2016). Treatment gains were also greater for those individuals receiving CSC soon after the onset of the initial psychosis episode.

The debate on improving mental health treatment in the United States is often seen as a dichotomous choice between increasing psychiatric treatment beds and providing additional resources for outpatient treatment. An expansion of both inpatient and outpatient care may be necessary, but a true evolution in the mental health treatment system can only occur by recognizing the importance of directing appropriate care to the right patients at the right time. Ultimately, longitudinal research efforts can inform this transformation, as noted again by Teich (2016):

> Improved data from modified survey methods or psychosis registries might help researchers to develop algorithms for estimating the frequency and intensity of episodes that are likely to require crisis intervention, short-term, and longer-term hospitalization among persons with SMI. (p. 66)

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[5] This four-pronged program, called NAVIGATE, included resilience-focused psychotherapy, family education and support, supported education and employment, and personalized medication management delivered in 17 clinics located throughout the United States.

Such investigatory efforts are vital to improving treatment approaches, reducing the current

burden on the health care and criminal justice systems, maintaining independence for patients

and transforming a fragmented and inadequate inpatient treatment system with an integrated and

intentional approach that fulfills the bold promise of fully supporting and effectively treating

persons with serious mental illnesses.

APPENDICES

APPENDIX A: Single Event Survival Model

	HR	95% C.I.
Female	1.04	(0.98-1.11)
White-Non Hispanic	1.03	(0.96-1.11)
Age (in decades)	0.98	(0.96-1.01)
Urban Residence	1.15**	(1.04-1.27)
Admitted to Hospital Outside Home Hospital Referral Region	0.90**	(0.83-0.98)
Discharged Home	1.06	(0.97-1.16)
Primary Diagnosis-Schizophrenia	1.96**	(1.67-2.29)
Primary Diagnosis-Bipolar Disorder	1.73**	(1.48-2.03)
Primary Diagnosis-Major Depressive Disorder	1.25**	(1.07-1.46)
Co-Occurring Personality Disorder	1.13*	(1.02-1.25)
Number of Chronic Conditions	0.99	(0.97-1.01)
Payer - Commercial	0.89*	(0.81-0.99)
Payer - Medicaid	1.00	(0.90-1.10)
Payer - Dual Eligible	1.19**	(1.07-1.33)
Length of Stay (Days)	1.00	(1.00-1.00)
Previous Psychiatric Hospitalizations	1.22**	(1.20-1.24)

* $p < .05$ \quad ** $p < .01$ \quad Likelihood Ratio = 841.6916 (16, $p<.0001$) n=17,650

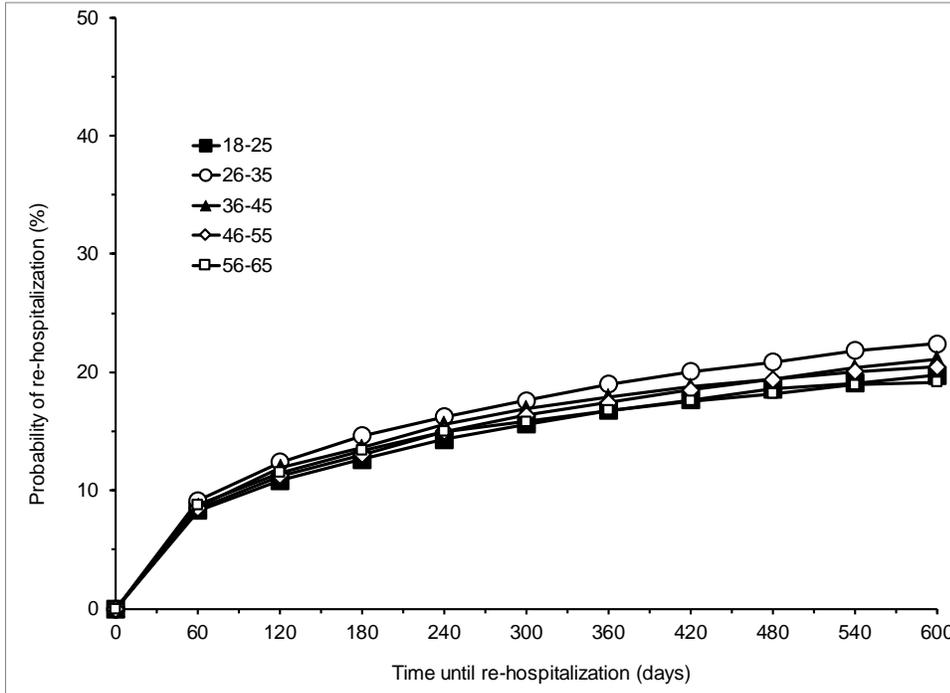APPENDIX B: Kaplan Meier Probabilities for Patient Re-hospitalization

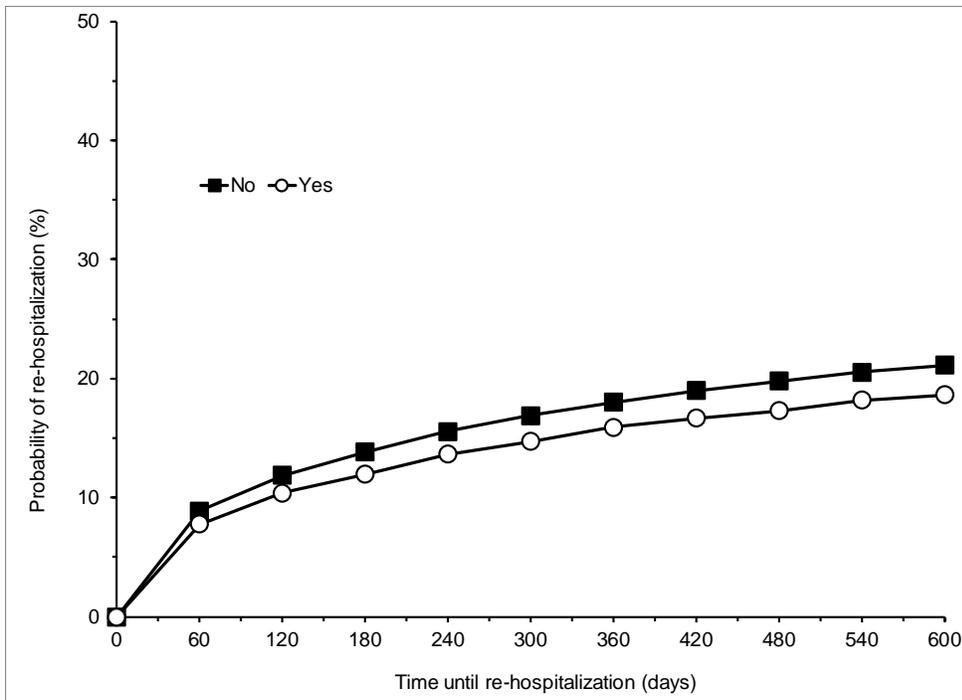*Figure C1*. Kaplan-Meier Probabilities for Patient Re-Hospitalization by Age Group

Figure C2. Kaplan-Meier Probabilities for Patient Re-Hospitalization by Patient Residence Outside Hospital Referral Region
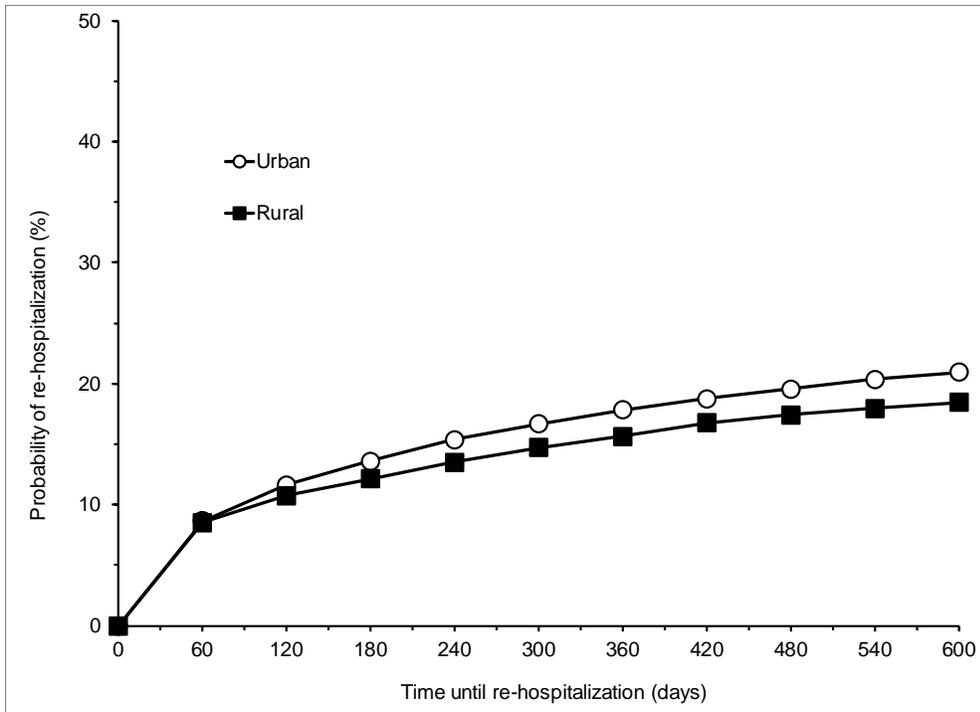
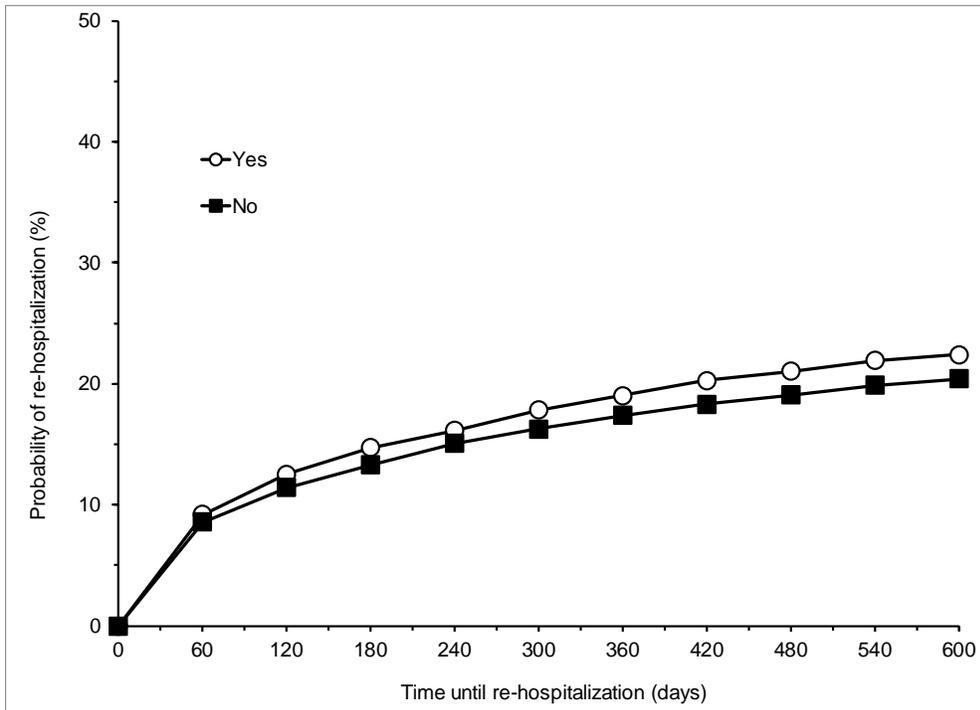*Figure C3*. Kaplan-Meier Probabilities for Patient Re-Hospitalization by Urban Residence

Figure C4. Kaplan-Meier Probabilities for Patient Re-Hospitalization by Co-Occurring Personality Disorder Diagnosis

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