Characteristics and Risk Factors for Hospital Readmission in the Ohio Medicaid Population

MEDTAPP 2001-2003 Research Project #2

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February 12, 2003

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SUMMARY

Hospitalization is one of the most costly medical services in Medicaid programs. The percentage of hospital readmissions averages between 21% and 27% in the United States. The purpose of this study is to describe the characteristics of readmitted Medicaid recipients and to identify the risk factors for hospital readmission among the Medicaid population. The characteristics and potential risk factors included in the study are based on a theoretical framework that hypotheses that a hospital readmission is determined by the patient's propensity for hospitalization as defined by predisposing, enabling, and need-related factors as well as the care a patient receives subsequent to the initial hospital discharge. A retrospective cohort research design was used for Medicaid patients hospitalized in calendar years 1999 or 2000. Hospital readmission was defined as an inpatient admission of a patient to a hospital within 90 days of an inpatient discharge from the same hospital. From Ohio Medicaid fee-for-service claims, a total of 37,312 recipients with at least one hospitalization were selected for this study, including 18,882 recipients who had hospital readmissions and 18,430 hospitalized but non-readmitted recipients as a comparison group. Major characteristics and patterns of hospitalization were examined. Chi-square and t-tests were used to compare the characteristics of the two groups. Logistic regression analysis was conducted to assess the risk factors associated with hospital readmission. For some analyses, the readmitted patients were subdivided based on time-to-readmission within 30 days, within 60 days, and within 90 days.

The findings of this study are:

- 6% of Ohio Medicaid recipients had at least one 90-day readmission; these hospitalization pairs accounted for almost 12% of total Medicaid hospitalizations during the study period.
- Patients less than 65 years old had as much as a fourfold risk of readmission, depending on the specific age group and time-to-readmission, as compared to patients age 65+.
- Of the other predisposing variables examined in this study, African American and "other" race (i.e., not white, black, or Hispanic) and urban county residence were associated with a somewhat increased risk of readmission (1.1 to 1.6 times the risk of the reference groups), with no significant relationship between readmission and gender.
- Of the Medicaid program enabling factors, ADB enrollment was associated with approximately a twofold increase in risk of readmission, whereas enrollment in either AFDC or CHIP had no effect on the risk of readmission.
- The hospitalization need factors reflective of severity of illness were associated with increased risk of readmission: emergency admissions were 1.5-1.8 times more likely than non-emergency admissions to have been readmitted, and there was a 3%-4% increase in risk of admission for each additional day of hospital stay during the initial hospitalization.
- Patients with six of the seven most frequent diagnoses among readmitted patients (diabetes, congestive heart failure, asthma, hypovolemia, chronic obstructive lung disease, and coronary arteriosclerosis) were at a somewhat

increased risk (1.1-1.3 times) of readmission. Hypertension, however, was not associated with increased risk.

- Non-readmitted patients were most likely to be hospitalized for pregnancy-related conditions; otherwise, the major diagnoses associated with the initial hospitalization for both readmitted and non-readmitted patients were similar: diabetes, fluid/electrolyte disorder, hypertension, nondependent drug abuse, and heart failure.
- With discharge status at the initial hospitalization used as a measure of a patient's post-discharge care, discharge to home with home care services was associated with a somewhat increased risk (1.2-1.4 times) of readmission, compared to discharge to home without home care services or discharge to a nursing home facility.
- Patients readmitted within 2-30 days and within 31-60 days were similar in terms of their predisposing, enabling, hospitalization need, and subsequent care characteristics but were different from patients readmitted within 61-90 days.
- Readmitted patients had similar hospitalization need and subsequent care characteristics at the first and second (i.e., readmission) hospitalizations.
- 11% of recipients with at least one of seven major diseases (diabetes, hypertension, congestive heart failure, asthma, chronic obstructive pulmonary disease, urinary tract infection, and coronary arteriosclerosis) did not receive any outpatient prescription drugs before, during, or after the initial hospitalization.

- Readmitted patients were more likely than non-readmitted patients to not have received any outpatient prescription drugs before, during, or after the initial hospitalization in total, as well as for four of the seven diagnostic subgroups (diabetes, hypertension, asthma, and urinary tract infection).
- While there were no significant differences between readmitted and non-readmitted patients in terms of not receiving any outpatient prescription drugs before and during their initial hospitalization, readmitted patients were significantly more likely than non-readmitted patients to not have received outpatient prescription drugs after their first hospitalization (23% vs. 18%, respectively).

The conclusions drawn from the findings of this study are:

- Hospital readmissions are relatively frequent events among the Medicaid population. They consume a sizeable proportion of Medicaid expenditures. As a result, a greater understanding of the nature, cause, appropriateness, and outcomes of hospital readmissions is needed, particularly given the dearth of research on hospital readmissions among Medicaid recipients.
- There are a number of predisposing, enabling, and hospitalization need factors that appear to be associated with the risk of readmission. Given the limitations of the Medicaid data files regarding the number and types of variables that could be examined, further analyses, using other existing or future databases, are required.

- Chronic physical health diseases are major reasons for hospitalization among the Medicaid population. Efforts to reduce the number of hospitalizations, including the number of costly hospital readmissions, should focus on these conditions through appropriate disease management programs. In particular, there is a need for a better understanding of the interrelationships among diabetes, hypovolemia, and outpatient prescription drug utilization, especially post-discharge drug utilization, and the extent to which these interrelationships may be underlying determinants of hospital admissions and readmissions.
- Future studies examining hospital readmissions should focus on readmissions within 60 days rather than 90 days. The underlying nature of the readmission process appears to be similar for patients readmitted within 30 days and those readmitted within 60 days. Use of a 90-day time-to-readmission may be confounded by the hospital utilization patterns of the elderly, resulting in the inclusion of unplanned, unrelated hospitalizations as hospital readmissions.
- Appropriate drug utilization is a significant issue that must be addressed with the Medicaid population to ensure not only effective medical and hospital care but also the prevention of adverse outcomes in terms of both patient health status and unnecessary hospitalization. With regard to hospital readmission, appropriate drug utilization, particularly post-discharge, appears to be a potentially significant determinant that warrants further study.

INTRODUCTION

Hospitalization is one of the most costly medical services in Medicaid programs. Between 1995 and 2000, the cost for hospitalization in the Ohio Medicaid Program averaged $1.7 billion (ODJFS, 1996-2002). This cost accounted for about 23%-30% of the total annual Medicaid expenditures from 1995 to 2000.

There is some evidence that Medicaid recipients have a greater risk of being readmitted for a subsequent hospitalization within 30 days of a previous hospitalization (Frankl et al. 1991, Corrigan & Martin 1992, Weissman et al. 1994, Druss et al. 1998, Philbin & DiSalvo 1998, Blixen et al. 1999, Philbin & DiSalvo 1999). Neff et al. (2002) reported that Medicaid children (0-17 years) in Washington State had higher multiple hospitalization rates than non-Medicaid children in 1991, with no differences between the two groups of children in 1998. Also, some studies have found that Medicare beneficiaries who are eligible for supplemental Medicaid coverage are at greater risk of readmission (Anderson & Steinberg 1984, Anderson & Steinberg 1985), while other studies have found no association (Holloway et al. 1988, Kellogg et at. 1991, Experton et al. 1999). A study of HMO enrollees 65 years and older, who are eligible for both Medicare and Medicaid, found that patients at high risk of repeat hospital admission averaged at least 2.3 times the resource utilization during a six month follow-up (Vojta et al. 2001).

These studies examined the issue of hospital readmission by Medicaid recipients from the perspective of whether Medicaid enrollment has an independent effect on hospital readmission when the study population consists of both Medicaid and non-Medicaid enrollees. Very few studies, however, have examined hospital readmissions only within the Medicaid population and, in particular, the risk factors associated with hospital readmission within that population. Of the published studies, some have looked at patient-related factors. For example, Klingman et al. (1990) reported that readmissions were more prevalent among Medicaid patients who underwent surgery for hysterectomy, cholecystectomy, appendectomy, and myringotomy. Levels of post-surgical utilization, expenditure, and complications were higher among females, older patients, Supplemental Security Income enrollees, and those with higher level of presurgical utilization and longer and more costly surgical stays. Chabra et al. (1998) found that the risk for multiple Medicaid-paid asthma hospitalizations within a year was greater among African-American and Latino children than among white children (ages 1-12). Hebert et al. (1999) concluded that age of 32 years, black ethnicity, and primiparity were predictors of serious maternal morbidity, including readmission, among women who delivered infants while enrolled in Tennessee's Medicaid program.

Other studies have examined the enrollment of Medicaid managed care on hospital readmissions. For example, a study of the long-term effects of Medicaid managed care on obstetric service use and program costs in California found that the number of months enrolled in Medi-Cal, number of prenatal emergency room visits, and number of pregnancy-related complications increased the risk of postpartum readmission. The

most frequent readmission diagnoses were renal disease, endometritis, and gallbladder disease (Tai-Seale et al. 2001). Also, Callahan et al. (1995) found that children and adolescents in a statewide specialty mental health managed care plan in Massachusetts had slightly higher readmission rates than before managed care was adopted.

While several studies have looked at early hospital discharge on the risk of readmission among Medicaid newborns (Fox & Kanarek 1995, Edmonson et al. 1997, Kotagal et al. 1999, Danielsen et al. 2000), at least two studies have focused on early discharge of the mother. Brumfield et al. (1998) found that Medicaid women who were discharged at 72 hours after cesarean delivery despite not meeting discharge criteria were more likely to be readmitted than women who met criteria. Bossert et al. (2001) concluded that the need for maternal readmission post-delivery was rare, with no effect of a "stayover mom" policy on hospital readmission.

In a study that examined the relationship between subsequent care post-discharge and hospital readmission, Huff (2000) reported that Medicaid mental health inpatients who utilized any psychotherapy, medication management, or diagnostic evaluation services post-discharge had significantly lower 30-day readmission rates and longer times in readmission. However, patients receiving above the median total number of ambulatory services, i.e., having contact with more providers, showed significantly greater likelihood of 30-day readmission, and shorter time in readmission.

While these studies do provide some insight into the underlying reasons and correlates of hospital readmission among the Medicaid population, a greater understanding of hospital readmissions among Medicaid recipients and the associated determinants and outcomes is needed as a basis for effective Medicaid program management policies.

Study Objectives

The primary purpose of this study was to identify the risk factors of hospital readmission within the Ohio Medicaid population. Specifically, this study addressed the following research questions:

- What is the prevalence of hospital readmissions within 90 days among the enrolled Medicaid population?
- What are the patient propensity and subsequent care factors associated with a hospital readmission for the Medicaid population?
- What are the most prevalent disease or diagnostic conditions associated with hospital readmission for the Medicaid population?
- What are the costs of hospitalization for readmitted and non-readmitted Medicaid patients?
- What are the risk factors associated with hospital readmission among the Medicaid population?
- To what extent is the patient's potential drug utilization pattern a risk factor for hospital readmission in the Medicaid population?

This study is significant because answers to these questions will provide Medicaid policy makers with a greater understanding of the characteristics of readmitted Medicaid patients and the risk factors contributing to hospital readmission for frequently occurring medical conditions.

METHODS

Study Design

A retrospective cohort design was used for this study. The data source was the Ohio Medicaid claims database that contains medical, institutional, and pharmacy claims. The study period was from January 1, 1999 to December 31, 2000. About 1.34 million fee-for-service recipients had claims during this study period.

Target Population and Study Samples

The target population for this study was Ohio Medicaid fee-for-service recipients with at least one hospitalization (N=386,681) between October 1, 1998 and March 31, 2001. This time period included 90 days before the start of the study period in order to determine whether an admission during the first 90 days of the study period was actually a rehospitalization for an admission that occurred prior to the start of the study period and was thus a readmission event. Similarly, 90 days after the end of the study period was included to determine whether any hospitalization near the end of the study period could be paired with a readmission that occurred beyond the end of the study period.

Figure 1 illustrates how study recipients (readmitted and non-readmitted patients) were selected from the target population:

Readmitted Patients (Readmission Group): Patients with two or more hospitalizations within 90 days during the study period were selected for potential inclusion in the readmission group, with adjustments made for the time frame boundaries. Of the 113,092 persons with multiple hospital claims between October 1, 1998 and March 31, 2001, 94,210 patients were excluded from the readmission group because they had one or more of the following characteristics:

- multiple records at different institutions during the same hospitalization period;
- all hospitalizations occurred outside of the study period, i.e., between October 1, 1998 and December 31, 1998 or between January 1, 2001 and March 31, 2001;
- all hospital readmission pairs straddled the study period time frame boundaries;
- newborn patient;
- hospital transfer (to other hospitals or other facilities);
- admitted pending, rehabilitation, denied, or other uninterpretable claim;
- left against medical advice, transferred to Medicare, or obvious coding errors;
- readmission more than 90 days after the first discharge;
- age < 0 (indicating anomalous data) or >100; and/or
- no ICD9 diagnosis code on the inpatient claim.

A total of 18,882 recipients who had two or more hospitalizations within 90 days comprised the final readmission group. For the purposes of this study, only the

first readmission pair (first and second hospital admission within 90 days) was selected for analysis. Any subsequent hospital readmissions were excluded.

Non-Readmitted Patients (Comparison Group): Medicaid patients with only one hospitalization during the study period were selected for inclusion in the comparison group. Of the 273,589 persons with only one hospital claim between October 1, 1998 and March 31, 2001, 129,933 patients were excluded because they had one or more of the following characteristics:

- all hospital admissions occurred between October 1, 1998 and December 31, 1998 or between January 1, 2001 and March 31, 2001;
- newborn patient;
- died during hospitalization and, thus, not at risk for readmission;
- hospital transfer (to other hospitals or other facilities);
- admitted pending, rehabilitation, denied, or other uninterpretable claim; and/or
- left against medical advice, transferred to Medicare, or obvious coding errors.

An additional 44,753 patients who initially had multiple hospital claims between October 1, 1998 and March 31, 2001 were then considered for inclusion in the comparison group because:

- they had a single hospital episode between January 1, 1999 and December 31, 2000 after application of the readmission group exclusion criteria; or

- none of their multiple hospital admissions met the 90-day time-to-readmission criterion. One hospital admission between January 1, 1999 and December 31, 2000 was randomly selected for inclusion in the comparison group.

Ten percent of the remaining 188,409 patients were randomly selected for the comparison group, which, after application of the following two additional exclusion criteria, resulted in a total of 18,430 non-readmitted patients:

- age < 0 or >100; and/or,
- no ICD9 diagnosis code on the inpatient claim.

Thus, a total of 37,312 recipients were selected for this study:18,882 recipients in the readmission group (readmitted patients) and 18,430 recipients in the comparison group (non-readmitted patients).

Definition of Hospital Readmission

A hospital readmission was defined as a pair of consecutive hospital admissions to the same hospital where the time between discharge from the first hospitalization and admission for the second hospitalization was less than or equal to 90 days. These hospital readmissions were further classified into three subgroups based on whether the time-to-readmission was less than or equal to 30 days, less than or equal to 60 days, and less than or equal to 90 days. Time-to-readmission of 1 day was considered to be a patient transfer and thus met one of the exclusion criteria.

This definition of hospital readmission excludes patient transfers, i.e., where the second hospitalization was at a different hospital than the first hospitalization. Also, no distinction was made in terms of type of readmission, i.e., planned vs. unplanned or related vs. unrelated readmission. The unit of analysis for the study was the patient, not the hospitalization, i.e., the focus was on unique patients readmitted within 90 days, not on hospital readmissions per se. Thus, to ensure that a readmitted patient was included only once in the study population, only the first readmission event, i.e., the first and second hospitalizations of a series of multiple hospital readmissions, was considered for analysis.

Theoretical Framework

The theoretical framework used in this study is a variation of the conceptual framework proposed by Ludke et al. (2002) for analyzing hospital readmissions. The data elements within the Medicaid files limited the variables that could be included in the analysis and thus limited the application of the full conceptual framework. The theoretical model applied within this study hypothesizes that the determinants of a hospital readmission include the following:

- Patient's propensity for hospitalization as defined by:
    - patient predisposing factors, e.g., demographic characteristics (age, gender, race, urban/rural location);
    - patient enabling factors, e.g., Medicaid enrollment characteristics (aid type, prior enrollment); and

- patient hospitalization need factors related to the first hospitalization (admission type, length of stay, diagnosis).

- Subsequent care factors as indicated by the first hospitalization discharge status.

In addition, the patterns of drug utilization before, during, and after the first hospitalization were hypothesized to be potential determinants of hospital readmission. Absence of prescription claims have not been examined previously as potential readmission risk factors in the hospital readmission literature.

Operational Definitions of Dependent and Independent Variables

The operational definitions of the dependent variable (readmission status) and each of the independent variables (patient propensity and subsequent care factors) are as follows:

Readmission Status: A dichotomous dependent variable indicating hospital readmission (1 = readmission group, 0 = comparison group).

Age: Recipient's age on the admission date of the first hospitalization, calculated as: (date of birth – first hospitalization admission date) / 365.25. Age was categorized into seven groups: 0-18 years, 19-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, and 65+ years. Data were extracted from the Medicaid eligibility file.

Gender: Defined as male = 1 and female = 0. Data were extracted from the Medicaid eligibility file.

Race: Defined as a categorical variable (White, Black, Hispanic, Other). Data were extracted from the Medicaid eligibility file.

Urban/Rural Location: A dichotomous variable indicating whether the recipient resided in an urban county or a non-urban (rural) county at the time of the initial hospitalization (urban = 1, rural = 0). A county code for a recipient's residency was extracted from the Medicaid monthly eligibility file. Of the 88 counties in Ohio, the following 38 counties were categorized as urban counties: Allen, Athens, Auglaize, Belmont, Butler, Carroll, Clark, Clermont, Cuyahoga, Delaware, Fairfield, Franklin, Fulton, Geauga, Greene, Hamilton, Jefferson, Lake, Lawrence, Licking, Lorain, Lucas, Madison, Mahoning, Medina, Miami, Montgomery, Pickaway, Portage, Richland, Stark, Summit, Trumbull, Tuscarawas, Union, Warren, Washington, and Wood.

Medicaid Aid Type: Enrollment in the Medicaid Program was defined by the following aid type variables:

- *Aid for Disability and Blind (ADB):* A dichotomous variable indicating whether or not a recipient was enrolled in Medicaid as a disabled or blind person during the initial hospitalization (1 = ADB enrolled, 0 = not ADB enrolled).

Data were extracted from the Medicaid monthly eligibility file with aid category code = 2 (blind) or 3 (disabled).

- *Aid to Family and Dependent Children (AFDC):* A dichotomous variable indicating whether or not a recipient was enrolled in Medicaid under AFDC during the initial hospitalization (1 = AFDC enrolled, 0 = not AFDC enrolled). Data were extracted from the Medicaid monthly eligibility file with aid category code = 4 (regular aid to dependent children) or 5 (aid to dependent children, unemployed parent).
- *Children's Health Insurance Plan (CHIP):* A dichotomous variable indicating whether or not a recipient was participating in the CHIP program or Ohio Healthy Start program at the time of the initial hospitalization (1 = CHIP participant, 0 = not CHIP participant). Data were extracted from the Medicaid monthly eligibility file with recipient case type code = I (Healthy Start, children >= ages 6-14 and up to 100% of poverty), J (Healthy Start, children age <19 and up to 150% of poverty), or K (CHIPS II, children with 150% - 200% of poverty). Recipients must be 18 years old or younger to be eligible for the CHIP program.

Prior Enrollment: A dichotomous variable indicating whether or not a recipient had 12-months of continuous enrollment in the Medicaid program prior to the initial hospitalization (1=continuous enrollment, 0=non-continuous enrollment).

Admission Type: A dichotomous variable indicating whether a recipient had either an emergency or a non-emergency admission at the initial hospitalization (1= emergency, 0 = non-emergency). Data were extracted from the inpatient claims file.

Length of Hospital Stay: The number of days a Medicaid recipient stayed in the hospital during the initial hospitalization. Data for this continuous variable were extracted from the institutional file.

Disease-Specific Diagnosis: Nine dichotomous variables indicating whether or not a recipient had a specific diagnosis of one of the following major diseases at the initial hospitalization (1 = present, 0 = absent): diabetes, hypertension, congestive heart failure (CHF), asthma, hypovolemia, chronic obstructive pulmonary disease (COPD), urinary tract infection (UTI), coronary arteriosclerosis, and pneumonia. Specification of the disease was based on the first 3-digits of the International Classification of Diseases Revision 9 (ICD9) diagnostic codes. It should be noted that recipients might have multiple diagnoses during a hospitalization. The inpatient claims file, from which the data were extracted, permits specification of up to 5 diagnoses per hospitalization.

Discharge Status: Subsequent care was defined by the categorical variable indicating a patient's discharge status at the end of the initial hospitalization. This variable consisted of three discharge categories: to home, to home health

care services, or to nursing home services, either a skilled nursing facility (SNF) or intensive care facility (ICF). Data were extracted from the inpatient claims file.

Drug Utilization Patterns Before, During, and After the Initial Hospitalization

Because patients with certain severe diseases need to rely on medications to control their morbidity and mortality, the frequency of patients who had no prescription claims was examined as a separate readmission risk factor. Three periods of potential drug utilization were analyzed:

- before the initial hospitalization: whether or not a patient had any pharmacy drug claims within 3 months before the initial hospitalization (the only hospitalization for the comparison group);
- during the initial hospitalization: whether or not a patient had any pharmacy drug claims during the initial hospitalization (from admission date to discharge date); and,
- after the initial hospitalization: whether or not a readmitted patient had any pharmacy drug claims between the initial hospitalization and the second hospitalization or whether or not a non-readmitted patient had any pharmacy drug claims within 3 months after the initial hospitalization.

The analysis of drug utilization patterns was conducted for seven frequently occurring diagnoses: diabetes mellitus (ICD9 codes 250.xx), hypertension (ICD9 codes 401.xx), congestive heart failure (CHF, ICD9 codes 428.xx), asthma (ICD9 codes 493.xx),

chronic obstructive pulmonary disease (COPD, ICD9 codes 496.xx), urinary tract infection (UTI, ICD9 codes 599.xx), and coronary arteriosclerosis (ICD9 codes 414.0-414.05). There were 8,524 readmitted patients and 6,595 non-readmitted patients who had at least one of these seven diagnoses.

Cost of Hospitalization

The cost of hospitalization was measured by the total dollar amount that Medicaid paid for hospital accommodation, medical therapy services, physician encounters, and radiology diagnosis fees for a recipient during his/her hospitalization. Data were extracted from the institutional file.

Statistical Analyses

All statistical analyses were performed using SAS® for Windows, version 8 (SAS Institute Inc., SAS Campus Drive, Cary, NC) and were conducted in four phases. First, univariate distributions of all variables were examined, which included data verification and the construction of the various variable categories. Second, descriptive bivariate analyses were conducted to compare readmitted and non-readmitted patients in terms of the propensity for hospitalization factors (demographic, Medicaid enrollment, hospitalization need characteristics), subsequent care factors (discharge status), cost of hospitalization, and drug utilization patterns. Differences between readmitted and non-readmitted patients were examined using contingency table (dichotomous variables) and t-test (continuous variables) analyses with a 0.05 significance level.

Third, logistic regression analyses were performed to assess the risk factors for hospital readmission. Analyses were conducted for the following groups of recipients:

- Patients readmitted within 30 days (2-30 days) compared to all non-readmitted patients;
- Patients readmitted within 60 days (2-60 days) compared to all non-readmitted patients; and,
- Patients readmitted within 90 days (2-90 days) compared to all non-readmitted patients.

Each of these regression analyses assessed the relative strength of the various individual risk factors (demographic, Medicaid enrollment, hospitalization need characteristics) on readmission status while statistically controlling for other risk factors at the 0.05 significance level. The categorical age variable was represented in the analyses by six dummy variables (0-18, 19-24, 25-34, 35-44, 45-54, 55-64 years), with age 65+ being the excluded reference category. Race was represented in the analyses by three dummy variables (Black, Hispanic, Other), with White being the excluded reference category. Discharge status was represented in the analyses by two dummy variables (Nursing Home, Home Health), with discharge to home being the excluded reference category. Length of stay was included in the analyses as a continuous variable, and all of the other variables were included as dichotomous (0,1) variables.

The fourth phase consisted of comparing the frequency of recipients without prescription drug claims before, during, and after the initial hospitalization. Differences

between readmitted and non-readmitted patients were examined using chi-square analyses at the 0.05 significance level.

RESULTS

Prevalence of Hospital Readmission

Based on the definition of hospital readmission used for the purposes of this study, 18,973 Medicaid recipients were readmitted within 90 days after a previous discharge during the study period. Thus, 6.0% of Medicaid recipients hospitalized during the study period had at least one 90-day readmission. Recipients with at least one 90-day readmission during the study period averaged 3.1 hospitalizations, for a total of 59,172 hospitalizations by readmitted patients. Of the 506,343 hospitalizations during the study period, 5.9% were 90-day readmissions, and 11.7% were multiple hospitalizations by recipients with at least one 90-day readmission.

Demographic and Medicaid Enrollment Characteristics

Table 1 lists the demographic and Medicaid enrollment characteristics of recipients in both the readmission and comparison groups. The readmission group is further subdivided by the time-to-readmission into three subgroups: 2-30 days, 31-60 days, and 61-90 days. Although all of the differences between the readmission group in total and the comparison group are statistically significant due to the large sample sizes, the readmission group in total substantively consisted of more Medicaid enrollees who were in the 35-64 age range (and fewer in the 19-24 age group), male, black, urban county residents, ADB enrollees, and enrolled continuously 12 months prior to the initial hospitalization than did the comparison group. Patients readmitted within 30 days and

those readmitted between 31 and 60 days were fairly similar in terms of their demographic and Medicaid enrollment characteristics. However, patients readmitted between 61 and 90 days were more likely than patients admitted within 60 days to be elderly (age 65+ years) and continuously enrolled in Medicaid for 12 months prior to their initial hospitalization, but less likely to be young (age 0-34 years) and ADB, AFDC, or CHIP enrollees.

Hospitalization Need and Subsequent Care Characteristics

The hospitalization need and subsequent care characteristics (except for diagnosis), based on the initial hospitalization for the readmission group and the only hospitalization for the comparison group, are presented in Table 2. Although all of the differences between the readmission group in total and the comparison group are statistically significant due to the large sample sizes, the readmission group in total substantively consisted of more patients who were emergency admissions and had longer average lengths of stay, particularly >8 days, than did the comparison group. There is no difference between the two groups in terms of subsequent care as measured by the patient's discharge status.

As with the demographic and Medicaid enrollment characteristics, patients readmitted within 30 days and those readmitted within 31-60 days were fairly similar in their hospital characteristics. However, these patients were more likely than patients readmitted within 61-90 days to have been emergency admissions and to have had slightly longer average lengths of stay. Patients readmitted within 61-90 days were

more likely to have been non-emergency admissions than patients readmitted within 60 days.

The hospitalization need and subsequent care characteristics based on the second hospitalization for the readmission group are presented in Table 3. Patients readmitted within 90 days had basically the same hospitalization need characteristics at the second hospitalization as they had at the initial hospitalization. Also, patients readmitted within 30 days not only were similar to patients readmitted between 31 and 60 days but also had the same hospitalization need characteristics as patients readmitted between 61 and 90 days.

Diagnoses

The 20 most frequently diagnosed diseases or conditions at initial hospitalization for the readmission and comparison groups are presented in Table 4. Diabetes mellitus (17.0%), fluid/electrolyte disorder (16.4%), essential hypertension (14.4%), nondependent drug abuse (10.2%), and heart failure (10.1%) were the most frequent diagnoses for patients who were subsequently readmitted within 90 days; whereas single live birth (25.9%), fluid/electrolyte disorder (12.8%), essential hypertension (12.6%), and diabetes mellitus (11.0%) were the most frequent diagnoses for non-readmitted patients. In general, readmitted patients were more likely of having diabetes mellitus and fluid/electrolyte disorder than non-readmitted patients but were less likely to have had newborn delivery-related conditions (Figure 2). While patients readmitted within 30 days and those readmitted within 31-60 days were similar in their diagnostic

characteristics at the initial hospitalization, patients readmitted within 61-90 days were more likely than patients admitted within 60 days to have had diabetes mellitus, hypertension, heart failure, and chronic airway obstruction diagnoses (Table 5).

In general, patients readmitted within 90 days had the same frequency of diagnosed diseases/conditions at the second hospitalization as at the initial hospitalization (Table 6). There was a slightly greater frequency of single, liveborn delivery (outcome of delivery) for readmitted patients at the second hospitalization than at the initial hospitalization (8.8% vs. 3.0%). As with the first hospitalization, patients readmitted within 30 days were similar in their diagnostic characteristics to those readmitted between 31 and 60 days, and patients readmitted within 61-90 days were more likely than patients admitted within 60 days to have had diabetes mellitus, hypertension, heart failure, and chronic airway obstruction diagnoses at the second hospitalization. All three subgroups of readmitted patients had similar diagnostic characteristics at the second hospitalization as they had at the initial hospitalization.

Based on the diagnostic characteristics of the patients readmitted within 90 days, several diagnosed diseases/conditions were selected for more detailed analysis:

Diabetes Mellitus (ICD9 250.xx): Diabetes mellitus was the most frequently diagnosed disease for readmitted patients at the initial hospitalization (17.0%) and the fourth most frequent diagnosis for non-readmitted patients (11.0%). Table 7 presents the diagnosis distribution for patients with diabetes mellitus. Of

readmitted patients with diabetes, 35.7% had type 1 diabetes and 64.3% had type 2 diabetes. This compares to 29.7% and 70.3%, respectively, for non-readmitted patients. The greatest difference in occurrence of diabetes between readmitted and non-readmitted patients was for ICD9 250.00: non-insulin dependent type 2 diabetes (40.4% vs. 48.2%).

Essential Hypertension (ICD9 401.xx): Essential hypertension was the third most frequently diagnosed disease for both readmitted and non-readmitted patients at the initial hospitalization (14.4% and 12.6%, respectively). Over 97% of readmitted and non-readmitted patients had a diagnosis of hypertension NOS (ICD9 401.9), with 3% having either malignant or benign hypertension (Table 8).

Heart Failure (ICD9 428.xx): Heart failure was the fifth most frequently diagnosed disease for readmitted patients at the initial hospitalization (10.1%) and the eighth most frequent diagnosed disease for non-readmitted patients (7.6%). As illustrated in Table 8, almost all (99.7%) of these patients had congestive heart failure (ICD9 428.9).

Asthma (ICD9 493.xx): Asthma was the ninth most frequently diagnosed disease for readmitted patients (7.3%) and the 17th most frequent diagnosis for non-readmitted patients (5.1%). As illustrated in Table 8, the three major asthmatic diagnoses were:

- Asthma without status asthmaticus (ICD9 493.90), occurring in 64.8% of readmitted asthma patients and 66.2% of non-readmitted asthma patients;
- Chronic obstructive asthma without mention of status (ICD9 493.20), occurring in 16.6% of readmitted patients and 15.3% of non-readmitted patients; and
- Asthma with status asthmaticus (ICD9 493.91), occurring in approximately 15% of both readmitted and non-readmitted patients.

Cost of Hospitalization

Table 9 presents the cost of hospitalization for readmitted and non-readmitted patients. Compared to non-readmitted patients, readmitted patients in total had higher average costs of hospitalization and, in particular, were more likely to have had hospital costs above $5,000 and less likely to have had hospital costs less than $3,000. Patients readmitted within 30 days had similar costs of hospitalization as patients readmitted within 31-60 days. However, patients readmitted with 61-90 days were more likely than patients admitted within 60 days to have had hospital costs less than $1,000. The cost distribution for second hospitalizations was essentially the same as for initial hospitalizations in all three subgroups.

Risk of Readmission

The results from the logistic regression analyses that compare readmitted patients to non-readmitted patients for the time-to-readmission subgroups are presented in Table 10 and are summarized as follows:

- Age: The risk of readmission decreased with time-to-readmission. Compared to patients 65+ years old, patients 0-55 years old had about 3.3 and 2.9 times the risk, respectively, of being readmitted within 30 and 60 days, while patients in the 55-64 age group had 4.0 and 3.5 times the risk, respectively. Compared to patients 65+ years old, a patient 0-64 years old was 1.4 to 1.8 times as likely to be readmitted within 90 days.
- Gender: Males were equally likely as females to be readmitted. No statistical significance was found.
- Race: Blacks and other non-white, non-Hispanic recipients were at a somewhat greater risk of being readmitted than white recipients. Black enrollees were approximately 1.2 times more likely than white enrollees to be readmitted. Compared to white enrollees, Medicaid enrollees of other ethnic (non-Hispanic) backgrounds were approximately 1.5 times more likely to be readmitted within 30 and 60 days and 1.3 times more likely to be readmitted within 90 days. Hispanic patients were as likely as white enrollees but less likely than black or other ethnic enrollees to be readmitted.
- Urban/Rural Location: Enrollees residing in urban counties were 1.1-1.2 times more likely to be readmitted than enrollees living in non-urban (rural) counties.

- Medicaid Aid Type: ADB recipients were 2.5 times, 2.6 times, and 1.8 times more likely than non-ADB recipients to be readmitted within 30, 60, and 90 days, respectively, while AFDC recipients were approximately 1.5 times more likely than non-AFDC recipients to be readmitted within 30 and 60 days. However, AFDC recipients were equally likely as non-AFDC recipients to be readmitted within 90 days. CHIP enrollees were not significantly different from non-CHIP enrollees in terms of readmission.
- Prior Enrollment: Medicaid recipients who were continuously enrolled in the 12-month period prior to the first hospitalization were approximately 1.2 times and 1.1 times less likely to be readmitted within 30 and 60 days, respectively, than recipients who were not continuously enrolled during this time period. However, continuously enrolled recipients were equally likely as non-continuously enrolled recipients to be readmitted within 90 days.
- Admission Status: Medicaid enrollees admitted as emergency patients at the time of the first hospitalization were 1.7 times, 1.8 times, and 1.5 times more likely than non-emergency-admitted patients to be readmitted within 30, 60, and 90 days, respectively.
- Length of Hospital Stay: The likelihood of being readmitted increased as the length of stay during the first hospitalization increased. For each additional day of hospital stay during the first hospitalization, the risk of being readmitted increased by 3%-4%.
- Disease Diagnosis: From the nine frequently diagnosed diseases included in the regression analyses, recipients with diabetes mellitus, congestive heart failure,

asthma, hypovolemia, and/or coronary arteriosclerosis were at slightly increased risk (1.1-1.3 times) for readmission. Although recipients with COPD were equally likely as recipients without COPD to be readmitted within 30 and 60 days, COPD recipients were 1.2 times more likely than recipients without COPD to be readmitted within 90 days. Recipients with hypertension and/or urinary tract infection were equally likely as recipients without these diseases to be readmitted. Recipients with pneumonia were 1.1-1.3 times less likely than recipients without pneumonia to be readmitted.

- Discharge Status: The risk of readmission for patients discharged to a nursing home decreased with time-to-readmission. Compared to enrollees discharged to home at the end of the first hospitalization, enrollees discharged to a nursing home (SNF/ICF) were 1.2 times more likely to be readmitted within 30 days, equally likely to be readmitted within 60 days, and 1.3 times less likely to be readmitted within 90 days. Patients discharged to home with home health services had 1.2-1.4 times greater risk of being readmitted than patients discharged to home without home health care. They were also at greater risk of being readmitted within 60 and 90 days than nursing home patients.

Drug Utilization Patterns

Table 11 summarizes the frequency of patients who had no prescription drugs dispensed before, during, and after their initial hospitalization for the 8,524 patients in the readmission group and the 6,595 patients in the comparison group who had at least

one of the seven selected diagnoses during their initial hospitalization. Some patients had more than one diagnosis during their hospitalization.

Approximately 11% of these patients did not receive any outpatient prescription drugs before, during, or after their first hospitalization. A significantly higher percentage of readmitted patients than non-readmitted patients did not receive any outpatient prescription drugs (12.3% vs. 9.6%, respectively). As illustrated in Figure 3, a significantly higher percentage of readmitted patients with diabetes mellitus, hypertension, asthma, and urinary tract infection did not receive any outpatient prescription drugs before, during, or after their first hospitalization. For congestive heart failure, chronic obstructive pulmonary disease, and coronary arteriosclerosis, there were no differences between the readmission and comparison groups.

About 20% of the patients with one or more of the selected diagnoses did not receive any outpatient prescriptions before their initial hospitalization, with no significant difference between readmitted and non-readmitted patients (19.7% vs. 20.1%, respectively). As illustrated in Figure 4, there were no significant differences between readmitted and non-readmitted patients for any of the diagnoses except for urinary tract infection. Readmitted patients with UTI were significantly more likely than non-readmitted patients with UTI to not have received any prescription drugs before their initial hospitalization (20.3% vs. 16.0%, respectively).

Over 48% of the patients with one or more of the selected diagnoses did not receive outpatient prescriptions during their initial hospitalization, with no significant difference between readmitted and non-readmitted patients (48.0% vs. 49.0%, respectively). As illustrated in Figure 5, there were no significant differences between readmitted and non-readmitted patients for any of the seven diagnoses.

Approximately 21% of the patients with one or more of the selected diagnoses did not receive outpatient prescription drugs after their first hospitalization, with readmitted patients being significantly more likely than non-readmitted patients to not have received outpatient prescription drugs (23.3% vs. 17.5%, respectively). As illustrated in Figure 6, the frequency of patients without prescription drugs after their initial hospitalization was higher for readmitted patients than for non-readmitted patients for diabetes mellitus, hypertension, asthma, urinary tract infection, and coronary arteriosclerosis. For congestive heart failure and chronic obstructive pulmonary disease, there were no differences between readmitted and non-readmitted patients.

DISCUSSION

Based on fairly stringent definitional criteria for a hospital readmission, 6% of Ohio Medicaid recipients during 1999-2000 were found to have had at least one 90-day readmission. These hospitalization pairs accounted for almost 12% of total Medicaid hospitalizations. This excludes multiple hospitalizations that occurred over time frame boundaries (i.e., the beginning and end of the study period) or were associated with hospital transfers. Given that the average cost of hospitalization for a readmitted patient was over $5,100, the estimated total annual cost of hospitalization by readmitted patients during the study period was around $152 million. In addition, the average cost of hospitalization for a readmitted patient was $2,263 higher than for a non-readmitted patient, resulting in an estimated annual cost of $67 million beyond that of non-readmitted patients with the same level of hospital utilization.

Of the predisposing variables examined in this study, age <65, black or other non-white/non-Hispanic ethnicity, and urban county residence were associated with increased risk of readmission, with no significant relationship between readmission and gender. Blacks were about 1.2 times as likely as whites to be readmitted, while the risk for other ethnic groups was slightly higher (1.3-1.6). More striking was the age effect. Patients younger than age 65 were up to 4 times more likely, depending on the specific age group and time-to-readmission, to be readmitted than patients of age 65+. This result may be due to missing data regarding readmission events that might have

occurred when an age 65+ Medicaid enrollee had a hospitalization that was covered by Medicare rather than Medicaid. On the other hand, the Medicaid claims database does contain a substantial number of "crossover" claims, and thus the increased risk for the younger age groups may be a real result. Urban recipients were more likely (1.1-1.2 times) to be readmitted than rural residents, probably because they have greater access to hospital-level services. In addition, rural residents may be more likely to be transferred from a rural hospital after an initial hospitalization rather than readmitted to the same hospital and, thus, excluded from the study. These results are not inconsistent with previous research, given that the literature on readmissions in general (Ludke et al. 2002) reports inconclusive findings regarding the relationship between hospital readmission and age, gender, race, and urban/rural location.

Of the Medicaid program enabling factors, ADB enrollment was associated with approximately a twofold increase in risk of readmission, whereas enrollment in either AFCD or CHIP had no effect on the risk of readmission. There are two possible explanations for this finding. First, AFDC and CHIP are limited to children, whereas ADB also includes older recipients, who may have a greater predisposition toward readmission due to their age. Second, the nature of the medical condition that would qualify enrollees of any age for ADB may also increase their need for multiple hospitalizations.

The hospitalization need factors reflective of severity of illness were associated with increased risk of readmission. Emergency admissions were 1.5-1.8 times more likely to

have been admitted than non-emergency admissions. In addition, there was a 3%-4% increase in risk of admission for each additional day of hospital stay during the initial hospitalization. Although, conceptually, one would expect a relationship between severity of illness and the risk of being readmitted, previous readmission literature on the general population has found inconsistent relationships between readmission and such indicators of severity (Ludke et al. 2002), with the relationships varying by the specific indicator and the patient's medical condition.

Based on the distribution of ICD codes among readmitted patients, the most frequent diagnoses (diabetes, hypertension, congestive heart failure, asthma, hypovolemia, chronic obstructive lung disease, and coronary arteriosclerosis) were selected for examination as specific hospitalization need factors. With the exception of hypertension, patients in each disease category were at a somewhat increased risk (1.1-1.3 times) of readmission. This is consistent with previous research that has found that patients with chronic conditions are at greater risk of hospital readmission (Ludke et al. 2002).

Non-readmitted patients were most likely to be hospitalized for pregnancy-related conditions. Otherwise, the major diagnoses associated with the initial hospitalization for both readmitted and non-readmitted patients were similar: diabetes, fluid/electrolyte disorder, hypertension, nondependent drug abuse, and heart failure. Diabetes is a highly prevalent condition among the Medicaid population, with 17% of readmitted and 11% of non-readmitted patients having this diagnosis. In addition, diabetic

complications appear to be major risk factors for hospitalization among patients with diabetes mellitus. Readmitted patients with diabetes were more likely than non-readmitted patients with diabetes to have renal and neurological manifestations. The prevalence of diabetes among the Medicaid population is consistent with that of the general population. For example, Aubert, et al. (1995) concluded that nearly 2.8 million hospitalizations among the general population nationally were associated with diabetes, which accounted for 24.5 million hospital days.

A relatively high percentage of both readmitted and non-readmitted patients had a diagnosis of fluid/electrolyte disorder (16% and 13%, respectively), particularly hypovolemia. Given the nature of diabetes and its treatment, this may be a comorbid condition associated with diabetes.

Hypertension is common throughout the world and represents the single greatest risk factor for increasing cardiovascular mortality, cardiovascular morbidity, and overall mortality. Hypertension requires frequent hospitalization and drug treatment (Mancia & Giannattasio 1996) and is a major comorbidity for many diseases, such as diabetes mellitus, congestive heart failure, and coronary disease. This diagnosis was present in over 14% of readmitted patients and almost 13% of non-readmitted patients in this study.

Approximately 10% of readmitted patients and almost 9% of non-readmitted patients had a diagnosis of nondependent drug abuse. This diagnosis is assigned to patients

who have come under medical care because of the maladaptive effect of a drug on which they are not dependent and have taken on their own initiative to the detriment of their health or social functioning. This implies the need for better education of Medicaid recipients regarding the use and misuse of prescription medications.

While heart failure tends to be the major diagnosis associated with hospital readmission among the general population, particularly Medicare recipients, it is not the predominant readmission-related disease condition among the Medicaid population. Heart failure is nevertheless prevalent among this population, being associated with 10% of readmitted patients and over 8% of non-readmitted patients, and is a risk factor for hospital readmission that cannot be overlooked. Although Ni et al. (1998) found no differences between Medicaid patients and other insurance groups with congestive heart failure in readmission rates, Philbin and DiSalvo (1998, 1999) have reported Medicaid enrollment as a risk factor for hospital readmission for congestive heart failure.

With discharge status at the initial hospitalization used as a measure of the patient's post-discharge care, discharge to home with home care services was associated with a somewhat increased risk (1.2-1.4 times) of readmission, compared to discharge to home without home care services or discharge to a nursing home facility. While the literature on hospital readmissions in general has found that use of home health care services reduces the risk of readmission, some studies have found that the use of home health care services increases the risk (Ludke et al. 2002). One possible explanation for the finding is that a home health care worker provides a professional level of patient

monitoring that permits identification of patients who are experiencing or progressing towards distress and require follow-up hospitalization. An alternative explanation is that patients who require home health care services may have greater severity of illness and thus be at greater risk of readmission.

Patients readmitted within 2-30 days and within 31-60 days were similar in terms of their predisposing, enabling, hospitalization need, and subsequent care characteristics but were different from patients readmitted within 61-90 days. Patients readmitted within 61-90 days were more likely to be elderly, continuously enrolled recipients, with greater severity of illness in terms of emergency admission and longer lengths of hospital stay, and with more chronic physical health conditions such as diabetes, hypertension, heart failure, and chronic obstructive pulmonary disease. In addition, 90-day readmissions tended to incur lower costs of hospitalization than 30-day or 60-day readmissions. Because patients readmitted within 61-90 days tended to be elderly, the use of a 90-day time span for defining a hospital readmission may result in more hospitalizations being identified as readmissions due to the greater hospital utilization patterns of the elderly. Thus, hospital readmissions within 61-90 days may be more likely to be unrelated to previous admissions than are readmissions within 60 days.

Readmitted patients had similar hospitalization need and subsequent care characteristics at the first and second hospitalizations. This implies that these patients were being treated for the same type of conditions, which tended to be chronic in nature. However, there was a significant increase in the percentage of single liveborn

deliveries at the second hospitalization, which suggests that the first hospitalization for these patients might be for pregnancy-related complications requiring hospitalization prior to delivery at the subsequent hospitalization.

Without reviewing the specific appropriate medication use for each disease category, this study found that 11% of recipients with at least one of seven major diseases (diabetes, hypertension, congestive heart failure, asthma, chronic obstructive pulmonary disease, urinary tract infection, and coronary arteriosclerosis) did not receive any outpatient prescription drugs before, during, or after the initial hospitalization. The frequency of this non-medication use was significantly higher for readmitted than for non-readmitted patients in total, as well as for four of the seven diagnostic subgroups (diabetes, hypertension, asthma, and urinary tract infection). While there were no significant differences between readmitted and non-readmitted patients in terms of not receiving any outpatient prescription drugs before and during their initial hospitalization, readmitted patients were more likely than non-readmitted patients to not receive outpatient prescription drugs after their first hospitalization. Almost one-quarter (23%) of readmitted patients did not receive outpatient prescription drugs between their first and second hospitalizations, as opposed to 18% in the non-readmitted group.

While the reasons for these findings are not readily apparent, patients with severe chronic diseases need to rely on medications to control their morbidity and mortality. It is not uncommon for patients to suffer painful clinical consequence or be hospitalized due to lack of medication compliance or to accessibility to essential medications.

Without appropriate medications, patients with diabetes mellitus will develop ketoacidosis and other complications. Without appropriate medications, patients with hypertension will develop stroke, coronary heart disease, congestive heart failure, and chronic renal insufficiency. Maronde and colleagues (1989) report that underutilization of antihypertensive drugs for patients with hypertension was associated with hospitalizations that could have been prevented if patients had complied with their medication schedules.

Without appropriate medications, patients with congestive heart failure (CHF) are associated with lower exercise tolerance, higher rate of hospitalization, and higher mortality rate. Clinical trials have demonstrated that patients with CHF who use angiotensin-converting-enzyme (ACE) inhibitors reduce their hospitalization and mortality rates (CONSENSUS, 1987; CDMRG, 1991). Also, substantial effort has been devoted to devise safe and effective programs to reduce preventable hospital admissions and readmissions for patients with CHF (Rich, et al, 1995; Kornowski, et al, 1995).

For patients with asthma, inhaled corticosteroids are effective at preventing asthma morbidity and mortality. Patients with asthma who receive regular use of inhaled corticosteroids would be associated with reductions of 31% hospital admissions and 39% of readmission (Suissa, 2002).

Therefore, further research is needed to better understand the relationship between appropriate drug utilization, particularly post-hospitalization, and patient outcomes. Lack of outpatient prescription drug use appears to be a significant subsequent care issue that needs to be examined further to assess its effect on hospital readmissions and patient health status.

Limitations

This study was limited to the Ohio Medicaid fee-for-service recipients, and thus the results may not be generalized to the entire Ohio Medicaid program or to Medicaid programs in other states. Due to nature of the claims database, the number and types of potential determinants of hospital readmission could not be included in the analyses. The study was limited to hospital readmissions as defined for the purposes of this study and not multiple hospitalizations in general.

CONCLUSIONS

As with the Medicare population, hospital readmissions are relatively frequent events among the Medicaid population. They consume a sizeable proportion of Medicaid expenditures. As a result, a greater understanding of the nature, cause, appropriateness, and outcomes of hospital readmissions is needed. Given the dearth of research on hospital readmissions among Medicaid recipients, this study provided an initial step in this direction.

There are a number of predisposing, enabling, and hospitalization need factors that appear to be associated with the risk of readmission. However, the limitations of the Medicaid data files restricted the number and types of variables that could be examined in order to better understand the potential determinants of hospital readmissions among the Medicaid population. Further analyses of hospital readmissions among the Medicaid population, using other existing or future databases, are required.

With the exception of pregnancy-related conditions, chronic physical health diseases are the major reasons for hospitalization among the Medicaid population. Efforts to reduce the number of hospitalizations, including the number of costly hospital readmissions, should begin by focusing on these conditions through appropriate disease management programs. Given the findings of this study, there is a particular

need for a better understanding of the interrelationships among diabetes, hypovolemia, and outpatient prescription drug utilization, especially post-discharge drug utilization, and of the extent to which these interrelationships may be underlying determinants of hospital admissions and readmissions.

Future studies examining hospital readmissions should focus on readmissions within 60 days. The findings from this study suggest that the underlying nature of the readmission process is similar for patients readmitted within 30 days to those readmitted within 60 days. Use of a 90-day time-to-readmission may be confounded by the hospital utilization patterns of the elderly, resulting in the inclusion of unplanned, unrelated hospitalizations as hospital readmissions.

The findings from this study and the supporting previous research suggests that appropriate drug utilization is a significant issue that must be addressed with the Medicaid population to ensure not only effective medical and hospital care but also prevention of adverse outcomes in terms of both patient health status and unnecessary hospitalization. With regard to hospital readmission, appropriate drug utilization, particularly post-discharge, appears to be a potentially significant determinant that warrants further study.

ACKNOWLEDGMENTS

The authors would especially like to thank Mitali Ghatak, MedTAPP Administrator, Robert Reed, Director of Medicaid Pharmacy Program, and Tammie Stroup, Manager of Pharmacy Program, for their invaluable support. Appreciation is due Raymond Jang, Anthony Louder, Daniel Acosta, Alfred Tuchfarber, and other colleagues for their suggestions and help.

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Table 1. Demographic and Medicaid Enrollment Variables for Recipients in Readmission and Comparison Groups at Initial Hospitalization

Characteristic	Comparison Group	Readmission Group			
		Total	2-30 Days	31-60 Days	61-90 Days
Count of Recipients	**18,430**	**18,882**	8,792	4,243	5,847
Demographics					
Average Age	41.6	42.8	37.5	38.8	53.6
Category					
0-18	12.7%	11.4%	13.6%	13.3%	6.6%
19-24	21.4%	14.2%	17.8%	16.6%	6.9%
25-34	15.6%	12.9%	15.5%	13.7%	8.3%
35-44	9.6%	13.1%	13.7%	13.4%	11.9%
45-54	8.4%	14.9%	14.9%	16.6%	13.8%
55-64	7.8%	16.4%	17.1%	17.4%	14.7%
65+	24.5%	17.2%	7.4%	9.0%	37.8%
Gender					
Female	76.0%	68.7%	68.4%	69.5%	68.7%
Male	24.0%	31.3%	31.6%	30.5%	31.3%
Race					
White	72.8%	67.1%	66.2%	65.6%	69.6%
Black	23.8%	29.7%	30.3%	31.1%	27.8%
Hispanic	2.1%	1.7%	1.8%	1.9%	1.4%
Other	1.4%	1.5%	1.8%	1.5%	1.2%
Location					
Urban	74.7%	79.9%	80.9%	80.2%	78.2%
Rural	25.3%	20.1%	19.1%	19.8%	21.8%
Medicaid Enrollment					
Aid Type					
Disabled/Blind (ADB)	26.3%	50.2%	52.5%	55.8%	42.8%
AFDC	46.2%	30.1%	38.7%	34.1%	14.2%
Other Medicaid	27.5%	19.7%	8.8%	10.1%	43.0%
CHIP*					
No	76.3%	85.9%	81.8%	84.0%	93.4%
Yes	23.7%	14.1%	18.2%	16.0%	6.6%
Prior Enrollment					
No	50.2%	44.1%	52.3%	47.2%	29.5%
Yes	49.8%	55.9%	47.7%	52.8%	70.5%

* Some Medicaid recipients had both AFDC and CHIP enrollments.

Table 2. Hospitalization Need and Subsequent Care Variables for Recipients in Readmission and Comparison Groups at Initial Hospitalization

Characteristic	Comparison Group	Readmission Group			
		Total	**2-30 days**	**31-60 days**	**61-90 days**
Count of Recipients	**18,430** (100%)	**18,882** (100%)	8,792 (100%)	4,243 (100%)	5,847 (100%)
Admission Type					
Emergency	31.9%	48.0%	51.2%	53.8%	39.0%
Non-Emergency	68.2%	52.0%	48.8%	46.2%	61.0%
Length of Stay					
Average	4.1	5.4	5.5	5.4	5.1
Category					
0	0.4%	0.2%	0.1%	0.1%	0.4%
1	14.5%	15.0%	16.5%	16.0%	12.1%
2	30.4%	18.7%	18.8%	20.3%	17.4%
3	19.1%	15.8%	15.6%	16.3%	15.9%
4	9.7%	11.7%	11.0%	11.1%	13.2%
5	6.3%	8.5%	7.5%	8.1%	10.2%
6	4.5%	6.1%	5.8%	5.7%	7.0%
7	3.4%	5.1%	4.7%	4.6%	6.0%
8+	11.7%	18.8%	20.0%	17.9%	17.7%
Discharge Status					
Home	88.5%	85.3%	84.7%	85.2%	86.2%
SNF/ICF	6.8%	7.31%	7.1%	6.8%	7.9%
Home Health Care	4.8%	7.4%	8.2%	7.9%	5.9%

Table 3. Rehospitalization Variables for Recipients in Readmission Group

Characteristic	Hospital Readmission Group			
	Total	**2-30 days**	**31-60 days**	**61-90 days**
Count of Recipients	**18,882** (100%)	8,792 (100%)	4,243 (100%)	5,847 (100%)
Admission Type				
Emergency	48.5%	54.4%	51.3%	37.6%
Non-Emergency	51.5%	45.6%	48.7%	62.4%
Length of Stay Average	5.3	5.4	5.1	5.2
Category				
0	0.3%	0.2%	0.2%	0.5%
1	12.1%	12.5%	12.7%	11.0%
2	21.4%	21.9%	23.6%	19.2%
3	16.6%	17.0%	16.6%	16.0%
4	11.8%	11.4%	11.5%	12.7%
5	8.5%	8.4%	7.6%	9.3%
6	6.0%	5.5%	6.2%	6.7%
7	5.1%	4.7%	4.5%	6.2%
8+	18.2%	18.4%	17.1%	18.4%
Discharge Status				
Home	81.5%	78.9%	82.0%	85.3%
SNF/ICF	7.9%	8.3%	7.4%	7.8%
Home Health Care	8.6%	10.5%	8.7%	5.7%
Died	2.0%	2.3%	1.9%	1.2%

Table 4. Frequently Diagnosed Diseases/Conditions for the Initial Hospitalization

Ranking	ICD9-3digit	Counts	%	Description
Readmission Group				
1	250	3211	17.0%	DIABETES MELLITUS
2	276	3095	16.4%	FLUID/ELECTROLYTE DIS
3	401	2726	14.4%	ESSENTIAL HYPERTENSION
4	305	1919	10.2%	NONDEPENDENT DRUG ABUSE
5	428	1906	10.1%	HEART FAILURE
6	780	1574	8.3%	COMA & OTHER GENERAL SYMPTOMS
7	648	1533	8.1%	OTH CURRENT COND IN PREG
8	599	1438	7.6%	URINARY TRACT DISOR
9	493	1383	7.3%	ASTHMA
10	414	1341	7.1%	OTH CHR ISCHEMIC HRT DIS
11	496	1286	6.8%	CHR AIRWAY OBSTRUCT NEC
12	644	1235	6.5%	EARLY/THREATENED LABOR
13	427	1118	5.9%	CARDIAC DYSRHYTHMIAS
14	491	1117	5.9%	CHRONIC BRONCHITIS
15	296	1093	5.8%	AFFECTIVE PSYCHOSES
16	486	1049	5.8%	PNEUMONIA, ORGANISM NOS
17	295	960	5.8%	SCHIZOPHRENIC DISORDERS
18	285	852	5.8%	ANEMIA NEC/NOS
19	646	760	5.8%	OTHER COMPL OF PREGNANCY
20	518	744	5.8%	OTHER LUNG DISEASES
Total Patients in Readmission Group			18,882	

Ranking	ICD9-3digit	Counts	%	Description
Comparison Group				
1	V27	4779	25.9%	OUTCOME OF DELIVERY
2	276	2367	12.8%	FLUID/ELECTROLYTE DIS
3	401	2321	12.6%	ESSENTIAL HYPERTENSION
4	250	2035	11.0%	DIABETES MELLITUS
5	664	1645	8.9%	PERINEAL TRAUM W DELIVER
6	648	1612	8.7%	OTH CURRENT COND IN PREG
7	305	1587	8.6%	NONDEPENDENT DRUG ABUSE
8	428	1409	7.6%	HEART FAILURE
9	599	1337	7.3%	URINARY TRACT DISOR
10	663	1264	6.9%	UMBILICAL CORD COMPLIC
11	780	1235	6.7%	COMA & OTHER GENERAL SYMPTOMS
12	656	1228	6.7%	OTH FETAL PROB AFF MOTH
13	486	1080	5.9%	PNEUMONIA, ORGANISM NOS
14	427	1072	5.8%	CARDIAC DYSRHYTHMIAS
15	496	1016	5.5%	CHR AIRWAY OBSTRUCT NEC
16	414	991	5.4%	OTH CHR ISCHEMIC HRT DIS
17	493	948	5.1%	ASTHMA
18	650	819	4.4%	NORMAL DELIVERY
19	296	784	4.3%	AFFECTIVE PSYCHOSES
20	285	765	4.2%	ANEMIA NEC/NOS
Total Patients in Comparison Group			18,430	

Table 5. Frequently Diagnosed Diseases/Conditions for Readmission Group at the Initial Hospitalization

Ranking	Diseases /Conditions	ICD9-3digit	Readmission Group (Initial Hospitalization)			
			Total	2-30 days	31-60 days	61-90 days
			18,882 (100%)	8,792	4,243	5,847
1	DIABETES MELLITUS	250	17.0%	14.0%	15.8%	22.4%
2	FLUID/ELECTROLYTE DIS	276	16.4%	15.3%	14.6%	19.3%
3	ESSENTIAL HYPERTENSION	401	14.4%	11.8%	13.5%	19.1%
4	NONDEPENDENT DRUG ABUSE	305	10.2%	11.1%	11.3%	7.9%
5	HEART FAILURE	428	10.1%	6.6%	8.4%	16.6%
6	GENERAL SYMPTOMS	780	8.3%	7.2%	8.6%	9.8%
7	OTH CURRENT COND IN PREG	648	8.1%	9.6%	10.8%	4.0%
8	URINARY TRACT DISOR	599	7.6%	6.2%	6.2%	10.7%
9	ASTHMA	493	7.3%	6.9%	8.5%	7.1%
10	OTH CHR ISCHEMIC HRT DIS	414	7.1%	5.4%	5.5%	10.7%
11	CHR AIRWAY OBSTRUCT NEC	496	6.8%	5.0%	5.7%	10.3%
12	EARLY/THREATENED LABOR	644	6.5%	8.9%	8.4%	1.7%
13	CARDIAC DYSRHYTHMIAS	427	5.9%	4.1%	4.5%	9.7%
14	CHRONIC BRONCHITIS	491	5.9%	3.9%	5.8%	9.0%
15	AFFECTIVE PSYCHOSES	296	5.8%	5.7%	6.0%	5.7%
16	PNEUMONIA, ORGANISM NOS	486	5.8%	4.5%	5.1%	7.5%
17	SCHIZOPHRENIC DISORDERS	295	5.8%	4.7%	5.1%	5.6%
18	ANEMIA NEC/NOS	285	5.8%	4.1%	4.5%	5.2%
19	OTHER COMPL OF PREGNANCY	646	5.8%	4.4%	5.3%	2.4%
20	OTHER LUNG DISEASES	518	5.8%	3.4%	4.0%	4.7%

Table 6. Frequently Diagnosed Diseases/Conditions for Readmission Group at the Rehospitalization

Ranking	Disease /Condition	Readmission Group (Rehospitalization)			
		Total	**2-30 days**	**31-60 days**	**61-90 days**
	Count of Recipients	**18882 (100%)**	8,792	4,243	5,847
1	Diabetes Mellitus (250.xx)	16.4%	13.1%	16.1%	21.6%
2	Fluid/Electrolyte disorder (276.xx)	16.2%	14.8%	13.3%	20.4%
3	Essential Hypertension (401.xx)	13.5%	10.9%	12.5%	18.4%
4	Heart Failure (428.xx)	11.2%	7.1%	9.4%	18.9%
5	Nondep Drug Abuse (305.xx)	9.0%	9.2%	10.1%	8.0%
6	Outcome of Delivery (V27.xx)	8.8%	10.3%	12.1%	4.3%
7	General Symptoms (780.xx)	8.3%	7.8%	8.2%	9.3%
8	Urinary Tract Disorder (599.xx)	7.1%	5.9%	6.1%	9.8%
9	Asthma (493.xx)	7.1%	6.4%	9.0%	6.7%
10	Chr Airway Obstruct Nec (496.xx)	6.9%	5.2%	5.9%	10.3%
11	Oth Chr Ischemic Hrt Disorder (414.xx)	6.8%	4.9%	5.5%	10.6%
12	Oth Current Cond in Preg (648.xx)	6.8%	8.3%	8.7%	3.0%
13	Cardiac Dysrhythmias (427.xx)	6.3%	4.4%	4.6%	10.4%
14	Chronic bronichitis (491.xx)	5.9%	3.8%	5.6%	9.4%
15	Affective Psychoses (296.xx)	5.7%	5.8%	5.8%	5.6%
16	Pneumonia, Organism NOS (486.xx)	5.5%	4.5%	5.5%	7.1%
17	Schizophrenic Disorders (295.xx)	5.2%	4.9%	5.0%	6.0%
18	Anemia NEC/NOS (285.xx)	4.7%	4.8%	4.2%	4.7%
19	Bacterial infection NEC (041.xx)	4.4%	4.7%	3.9%	4.2%
20	Oth Lung diseases (518.xx)	4.3%	3.9%	4.1%	5.1%

Table 7. Diagnosis Distribution at Initial Hospitalization for Diabetes Mellitus

ICD9 code	Description of Disease	Comparison Group		Readmission Group	
		N	%	N	%
250	Diabetes mellitus	1	0.05%	0	0.00%
2500	Diabetes mellitus without complication	1	0.05%	1	0.03%
25000	Diabetes mellitus type II	981	48.21%	1297	40.39%
25002	Type II [non-insulin dependent] [NIDDM] [adult-onset type] uncontrolled	122	6.00%	116	3.61%
2501	Diabetes with ketoacidosis	1	0.05%	0	0.00%
25010	Diabetes mellitus type 2 or unspecified type with ketoacidosis not stated	8	0.39%	12	0.37%
25012	Diabetes mellitus type 2 or unspecified type with ketoacidosis	4	0.20%	5	0.16%
25020	Diabetes mellitus type 2 or unspecified type with hyperosmolarity not stated	9	0.44%	7	0.22%
25022	Diabetes mellitus type 2 or unspecified type with hyperosmolarity uncontrolled	4	0.20%	4	0.12%
25030	Diabetes mellitus type 2 or unspecified type with other coma not stated	0	0.00%	3	0.09%
25032	Diabetes mellitus type 2 or unspecified type with other coma uncontrolled	0	0.00%	1	0.03%
25040	Diabetes mellitus type 2 or unspecified type with renal manifestations	41	2.01%	146	4.55%
25042	Diabetes mellitus type 2 or unspecified type with renal manifestations uncontrolled	11	0.54%	17	0.53%
25050	Diabetes mellitus type 2 or unspecified type with ophthalmic manifestations	24	1.18%	48	1.49%
25052	Diabetes mellitus type 2 or unspecified type with ophthalmic manifestations	9	0.44%	5	0.16%
25060	Diabetes mellitus type 2 or unspecified type with neurological manifestation	68	3.34%	135	4.20%
25062	Diabetes mellitus type 2 or unspecified type with neurological manifestation	15	0.74%	32	1.00%
25070	Diabetes mellitus type 2 or unspecified type with peripheral circulatory disease	15	0.74%	34	1.06%
25072	Diabetes mellitus type 2 or unspecified type with peripheral circulatory disease	5	0.25%	8	0.25%
25080	Diabetes mellitus type 2 or unspecified type with other manifestations not	45	2.21%	75	2.34%
25082	Diabetes mellitus type 2 or unspecified type with other manifestations uncontrolled	15	0.74%	19	0.59%
2509	Diabetes with unspecified complication	1	0.05%	0	0.00%
25090	Diabetes mellitus type 2 or unspecified type with unspecified manifestation	35	1.72%	90	2.80%
25092	Diabetes mellitus type 2 or unspecified type with unspecified manifestation	15	0.74%	10	0.31%

Table 7. (continued)

ICD9 code	Description of Disease	Comparison Group		Readmission Group	
		N	%	N	%
25001	Diabetes mellitus type I	323	15.87%	453	14.11%
25003	Type I [insulin dependent] [IDDM] [juvenile type] uncontrolled	44	2.16%	46	1.43%
25011	Diabetes mellitus type 1 with ketoacidosis not stated as uncontrolled	45	2.21%	96	2.99%
25013	Diabetes mellitus type 1 with ketoacidosis uncontrolled	11	0.54%	20	0.62%
25021	Diabetes mellitus type 1 with hyperosmolarity not stated as uncontrolled	2	0.10%	4	0.12%
25023	Diabetes mellitus type 1 with hyperosmolarity uncontrolled	1	0.05%	4	0.12%
25033	Diabetes mellitus type 1 with other coma uncontrolled	1	0.05%	2	0.06%
25041	Diabetes mellitus type 1 with renal manifestations not stated as uncontrolled	36	1.77%	103	3.21%
25043	Diabetes mellitus type 1 with renal manifestations uncontrolled	8	0.39%	17	0.53%
25051	Diabetes mellitus type 1 with ophthalmic manifestations not stated as unco	18	0.88%	58	1.81%
25053	Diabetes mellitus type 1 with ophthalmic manifestations uncontrolled	4	0.20%	12	0.37%
25061	Diabetes mellitus type 1 with neurological manifestations not stated as uncontrolled	47	2.31%	141	4.39%
25063	Diabetes mellitus type 1 with neurological manifestations uncontrolled	7	0.34%	21	0.65%
25071	Diabetes mellitus type 1 with peripheral circulatory disorders not stated	12	0.59%	32	1.00%
25073	Diabetes mellitus type 1 with peripheral circulatory disorders uncontrolle	1	0.05%	3	0.09%
25081	Diabetes mellitus type 1 with other manifestations not stated as uncontrolled	20	0.98%	68	2.12%
25083	Diabetes mellitus type 1 with other manifestations uncontrolled	6	0.29%	14	0.44%
25091	Diabetes mellitus type 1 with unspecified manifestation not stated as uncontrolled	12	0.59%	49	1.53%
25093	Diabetes mellitus type 1 with unspecified manifestation uncontrolled	7	0.34%	3	0.09%
Subtotal		2035	100%	3211	100%

Table 8. Diagnosis Distribution at Initial Hospitalization for Recipients with Other Major Diseases

ICD9 /Disease	Description of Diseases	Comparison Group Recipient#	Comparison Group %	Readmission Group Recipient#	Readmission Group %
Essential Hypertension					
4010	Malignant hypertension	27	1.16%	36	1.32%
4011	Benign hypertension	27	1.16%	30	1.10%
4019	Hypertension NOS	2267	97.67%	2660	97.58%
Subtotal		2321	100%	2726	100%
Heart Failure					
4280	Congestive heart failure	1405	99.72%	1900	99.69%
4281	Acute pulmonary edema with heart disease	2	0.14%	6	0.31%
4289	Heart failure unspecified	2	0.14%	0	0.00%
Subtotal		1409	100%	1906	100%
Asthma					
49300	Extrinsic asthma without status asthmaticus	14	1.48%	22	1.59%
49301	Extrinsic asthma with status asthmaticus	4	0.42%	6	0.43%
49311	Intrinsic asthma with status asthmaticus	0	0.00%	1	0.07%
49320	Chronic obstructive asthma without mention of status	145	15.30%	230	16.63%
49321	Chronic obstructive asthma with status asthmaticus	10	1.05%	24	1.74%
49322	Chronic obstructive asthma with acute exacerbation	3	0.32%	0	0.00%
4939	Asthma unspecified	0	0.00%	1	0.07%
49390	Asthma without status asthmaticus	628	66.24%	896	64.79%
49391	Asthma with status asthmaticus	140	14.77%	203	14.68%
49392	Asthma with acute exacerbation	4	0.42%	0	0.00%
Subtotal		948	100%	1383	100%
COPD					
496.xx	Chronic obstructive pulmonary disease	1016	100%	1286	100%
Urinary Track Disorders					
5990	Urinary tract infection NOS	1216	91%	1268	88%
599.1x-599.9x	Other Urinary tract disorder	121	9%	170	12%
Subtotal		1337	100%	1438	100%
Coronary Artherosclerosis					
4140	Coronary artery disease	185	20.13%	457	36.91%
41400	Of unspecified type of vessel native or graft	237	25.79%	301	24.31%
41401	Coronary atherosclerosis of native vessel	475	51.69%	463	37.40%
41402	Coronary atherosclerosis of autologous vein bypass graft	18	1.96%	13	1.05%
41404	Of artery bypass graft	2	0.22%	3	0.24%
41405	Of unspecified type of bypass graft	2	0.22%	1	0.08%
414.1x-414.9x	other CAD	72	7.83%	103	8.32%
Subtotal		991	100%	1341	100%

Table 9. Costs of Hospitalization for the Initial Hospitalization and Re-hospitalization

Characteristic	Comparison Group	Readmission Group			
		Total	**2-30 days**	**31-60 days**	**61-90 days**
Count of Recipients	**18,430** (100%)	**18,882** (100%)	8,792 (100%)	4,243 (100%)	5,847 (100%)
Cost of Initial Hospitalization					
Per Average Cost	$2,873	$5,136	$6,245	$5,784	$2,997
Cost category					
Less than $1001	36.0%	21.0%	4.1%	6.8%	56.7%
$1001 - $2000	13.2%	10.7%	13.3%	13.0%	5.2%
$2001 - $3000	20.1%	14.5%	17.6%	17.2%	7.9%
$3001 - $4000	12.0%	13.4%	15.5%	15.8%	8.6%
$4001 - $5000	7.0%	11.5%	13.0%	15.0%	6.8%
$5001 - $10000	8.6%	19.4%	24.1%	22.6%	10.1%
More than $10000	3.1%	9.4%	12.4%	9.6%	4.8%
Cost of Re-hospitalization					
Per Average Cost	N/A	$4,917	$5,934	$5,543	$2,932
Cost category	N/A				
Less than $1001		20.7%	3.6%	6.8%	56.6%
$1001 - $2000		7.1%	9.0%	8.2%	3.5%
$2001 - $3000		14.9%	18.5%	17.6%	7.6%
$3001 - $4000		15.7%	18.8%	18.2%	9.2%
$4001 - $5000		12.3%	14.4%	15.0%	7.2%
$5001 - $10000		29.8%	25.1%	22.4%	11.7%
More than $10000		8.6%	10.8%	9.9%	4.3%

Table 10. Odds Ratios of Likelihood for Hospital Readmission in Ohio Medicaid Inpatient Recipients

Variable	Within 30 Days Odds Ratio (95% CI)	Within 60 Days Odds Ratio (95% CI)	Within 90 Days Odds Ratio (95% CI)
Gender			
Female	1.00	1.00	1.00
Male	1.017 (0.952 – 1.088)	0.990 (0.933 – 1.051)	1.014 (0.962– 1.068)
Race			
White	1.00	1.00	1.00
Black	1.176 (1.102 – 1.254)	1.187 (1.120 – 1.257)	1.166 (1.107 – 1.227)
Hispanics	0.830 (0.681 – 1.012)	0.864 (0.726 – 1.028)	0.868 (0.742 – 1.015)
Other	1.569 (1.258 – 1.957)	1.536 (1.257 –1.877)	1.275 (1.067 – 1.524)
Age Category			
0-18	3.327 (2.746 – 4.031)	2.946 (2.496 – 3.478)	1.439 (1.259 – 1.644)
19-24	3.341 (2.755 – 4.051)	2.953 (2.499 – 3.490)	1.428 (1.249 – 1.632)
25-34	3.324 (2.745 –4.027)	2.852 (2.415 – 3.368)	1.449 (1.269 – 1.654)
35-44	3.264 (2.709 – 3.933)	2.860 (2.433 – 3.361)	1.559 (1.373 – 1.771)
45-54	3.334 (2.773 – 4.008)	2.953 (2.517 – 3.464)	1.607 (1.417 – 1.823)
55-64	4.040 (3.398 – 4.803)	3.500 (3.014 – 4.064)	1.803 (1.604 – 2.027)
65+	1.00	1.00	1.00
Location			
Rural	1.00	1.00	1.00
Urban	1.179 (1.100 – 1.264)	1.154 (1.085 – 1.226)	1.103 (1.046 – 1.163)
Aid Types			
CHIP	0.925 (0.851 – 1.006)	0.933 (0.866 – 1.005)	0.943 (0.880 – 1.012)
ADB	2.467 (2.142 – 2.840)	2.624 (2.316 – 2.972)	1.764 (1.592 – 1.956)
AFDC	1.500 (1.282 – 1.755)	1.521 (1.324 – 1.747)	0.903 (0.802 – 1.016)
Prior Enrollment			
Non-Continuous	1.00	1.00	1.00
Continuous	0.859 (0.806 – 0.915)	0.889 (0.840 – 0.941)	0.992 (0.943 – 1.044)

Table 10. (continued)

Variable	Within 30 Days Odds Ratio (95% CI)	Within 60 Days Odds Ratio (95% CI)	Within 90 Days Odds Ratio (95% CI)
Admission			
Non-Emergency	1.00	1.00	1.00
Emergency	1.719 (1.619 – 1.824)	1.769 (1.678 – 1.865)	1.512 (1.442 – 1.585)
Length of Stay	1.040 (1.034 – 1.046)	1.039 (1.033 –1.044)	1.030 (1.025 – 1.035)
Disease Specific Diagnosis			
Diabetes Mellitus	1.161 (1.058 – 1.274)	1.199 (1.105 – 1.301)	1.269 (1.185 – 1.358)
Hypertension	0.919 (0.836 – 1.010)	0.940 (0.864 – 1.021)	0.947 (0.885 – 1.014)
Congestive Heart Failure	1.189 (1.049 – 1.347)	1.257 (1.128 – 1.400)	1.325 (1.220 – 1.439)
Asthma	1.131 (1.010 – 1.266)	1.200 (1.086 – 1.327)	1.257 (1.149 – 1.377)
Hypovolemia	1.270 (1.161 – 1.390)	1.232 (1.137 – 1.335)	1.200 (1.122 – 1.283)
COPD	1.094 (0.955 – 1.254)	1.122 (0.995 – 1.264)	1.164 (1.060 – 1.279)
Urinary Tract Infection	1.050 (0.930 – 1.185)	1.049 (0.943 – 1.167)	1.068 (0.981 – 1.163)
Coronary Atherosclerosis	1.255 (1.095 – 1.440)	1.226 (1.086 – 1.384)	1.251 (1.137 – 1.376)
Pneumonia	0.745 (0.653 – 0.851)	0.774 (0.689 – 0.869)	0.874 (0.800 – 0.955)
Discharge Status			
Home	1.00	1.00	1.00
Nursing Home	1.160 (1.021 – 1.318)	1.111 (0.992 – 1.244)	0.797 (0.728 – 0.874)
Home Health Care	1.428 (1.276 – 1.597)	1.375 (1.242 – 1.523)	1.201 (1.094 – 1.318)

Table 11. Frequency of Patients without Prescription Drugs Dispensed before, during, and after Initial Hospitalization by Disease Category

	Comparison Group					Readmission Group				
Disease Group	#Recip_ Total	#Recip_Non-Rx (before, during, & after hosp)	Before Hosp	During Hosp	After Hosp	#Recip_T otal	#Recip_Non-Rx (before, during, & after first hosp)	Before Hosp	During Hosp	After Hosp
Diabetes Mellitus	2035	165	360	1000	278	3211	333	515	1596	615
(%)		8.11%	17.69%	49.14%	13.66%		10.37%	16.04%	49.70%	19.15%
chi-square (readmission vs. comparison)							7.42	2.45	0.16	26.6
p-value							0.0064	0.1179	0.6905	<0.0001
Hypertension	2321	232	430	1183	323	2726	375	550	1349	667
(%)		10.00%	18.53%	50.97%	13.92%		13.76%	20.18%	49.49%	24.47%
chi-square (readmission vs. comparison)							16.76	2.18	1.1	88.52
p-value							<0.0001	0.1398	0.2936	<0.0001
Congestive Heart Failure	1404	127	221	713	290	1906	207	305	913	354
(%)		9.05%	15.74%	50.78%	20.66%		10.86%	16.00%	47.90%	18.57%
chi-square (readmission vs. comparison)							3.05	0.06	2.37	2.09
p-value							0.0807	0.8048	0.124	0.1484
Asthma	948	87	235	427	178	1383	171	296	631	386
(%)		9.18%	24.79%	45.04%	18.78%		12.36%	21.40%	45.63%	27.91%
chi-square (readmission vs. comparison)							5.80	3.67	0.08	25.58
p-value							0.0160	0.0555	0.7811	<0.0001
COPD	1016	113	188	485	209	1286	146	221	612	258
(%)		11.12%	18.50%	47.74%	20.57%		11.35%	17.19%	47.59%	20.06%
chi-square (readmission vs. comparison)							0.03	0.6757	0.0049	0.09
p-value							0.8617	0.4111	0.9442	0.7631
Urinary Tract Infect	1216	79	194	511	229	1268	137	257	530	292
(%)		6.50%	15.95%	42.02%	18.83%		10.80%	20.27%	41.80%	23.03%
chi-square (readmission vs. comparison)							14.51	7.77	0.01	6.59
p-value							0.0001	0.0053	0.9096	0.0102
Coronary Artherosclerosis	919	112	199	501	147	1238	172	244	626	289
(%)		12.19%	21.65%	54.52%	16.00%		13.89%	19.71%	50.57%	23.34%
chi-square (readmission vs. comparison)							1.34	1.22	3.3	17.66
p-value							0.2465	0.2689	0.0693	<0.0001
Subtotal	6,595	630	1326	3234	1154	8,524	1052	1676	4095	1988
		9.55%	20.11%	49.04%	17.50%		12.34%	19.66%	48.04%	23.32%
chi-square (readmission vs. comparison)							29.25	0.46	1.48	76.61
p-value							<0.0001	0.4973	0.2241	<0.0001

Figure 1. Selection of Study Samples from Target Population

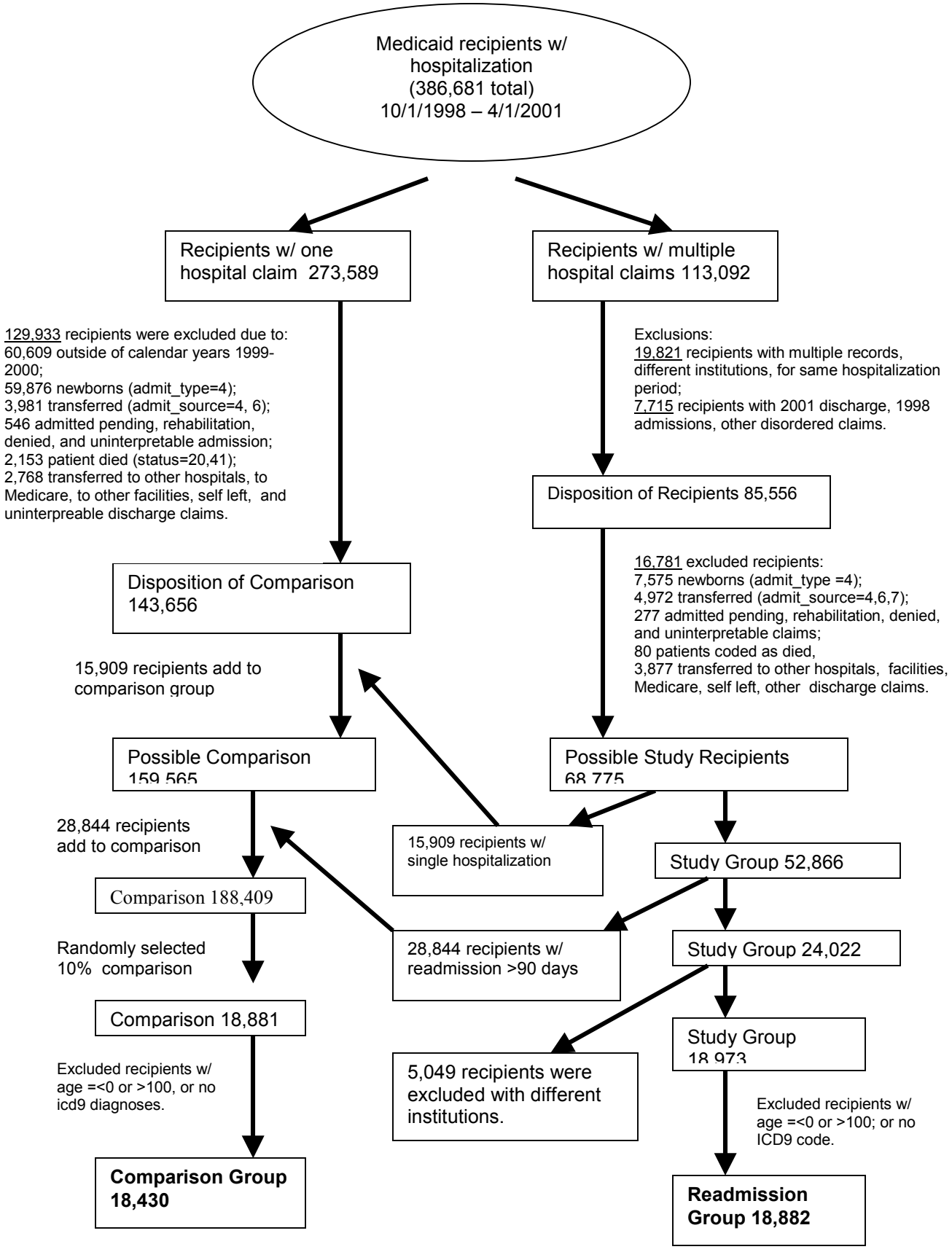

FIGURE2. FREQUENCY OF DISEASE CATEGORY IN INITIAL HOSPITALIZATION BY STUDY GROUP

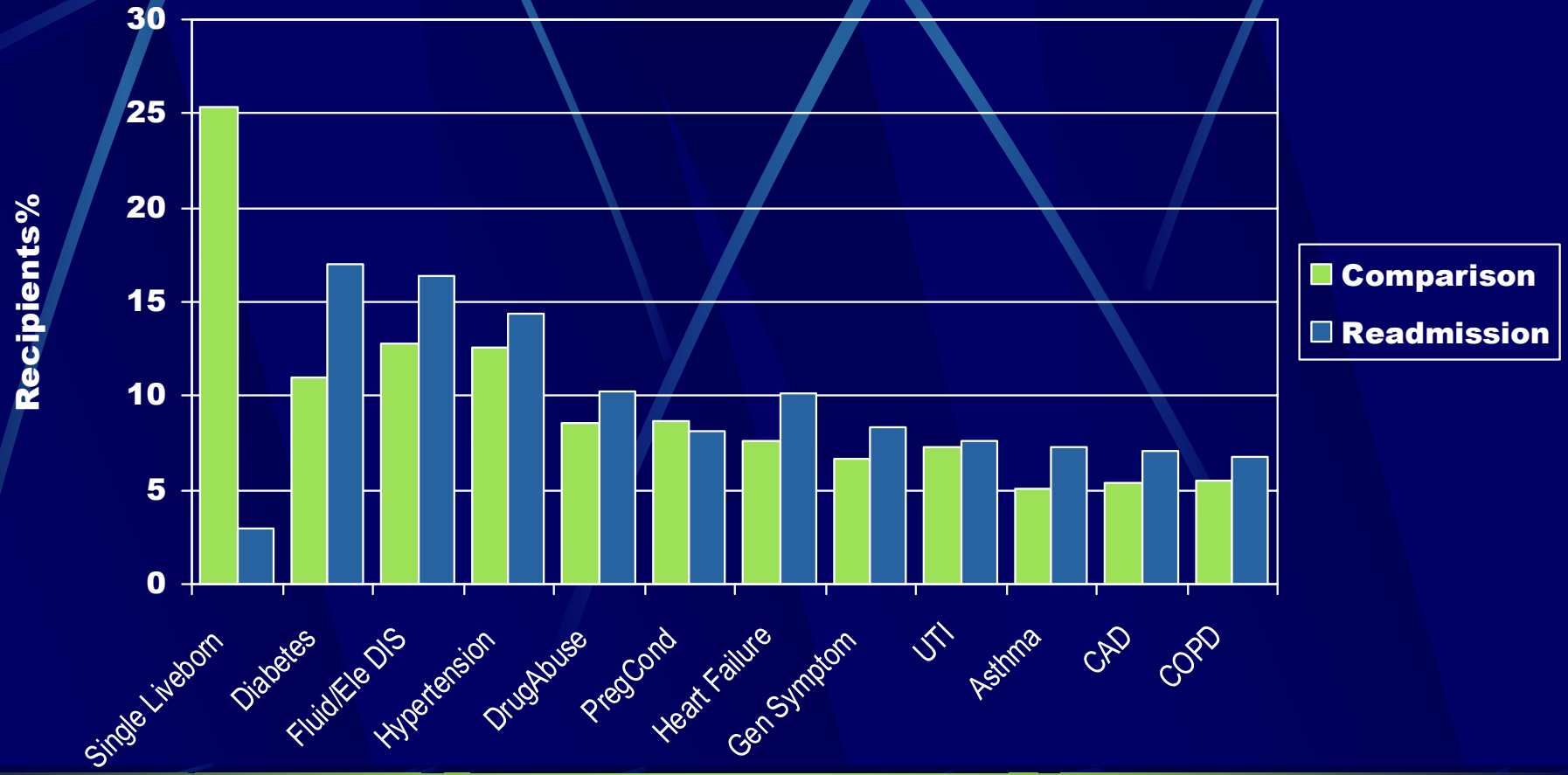

FIGURE 3. FREQUENCY OF RECIPIENTS WITHOUT OUTPATIENT PRESCRIPTIONS DISPENSED BEFORE, DURING, AFTER INITIAL HOSPITALIZATION FOR EACH STUDY GROUP BY DISEASE CATEGORY

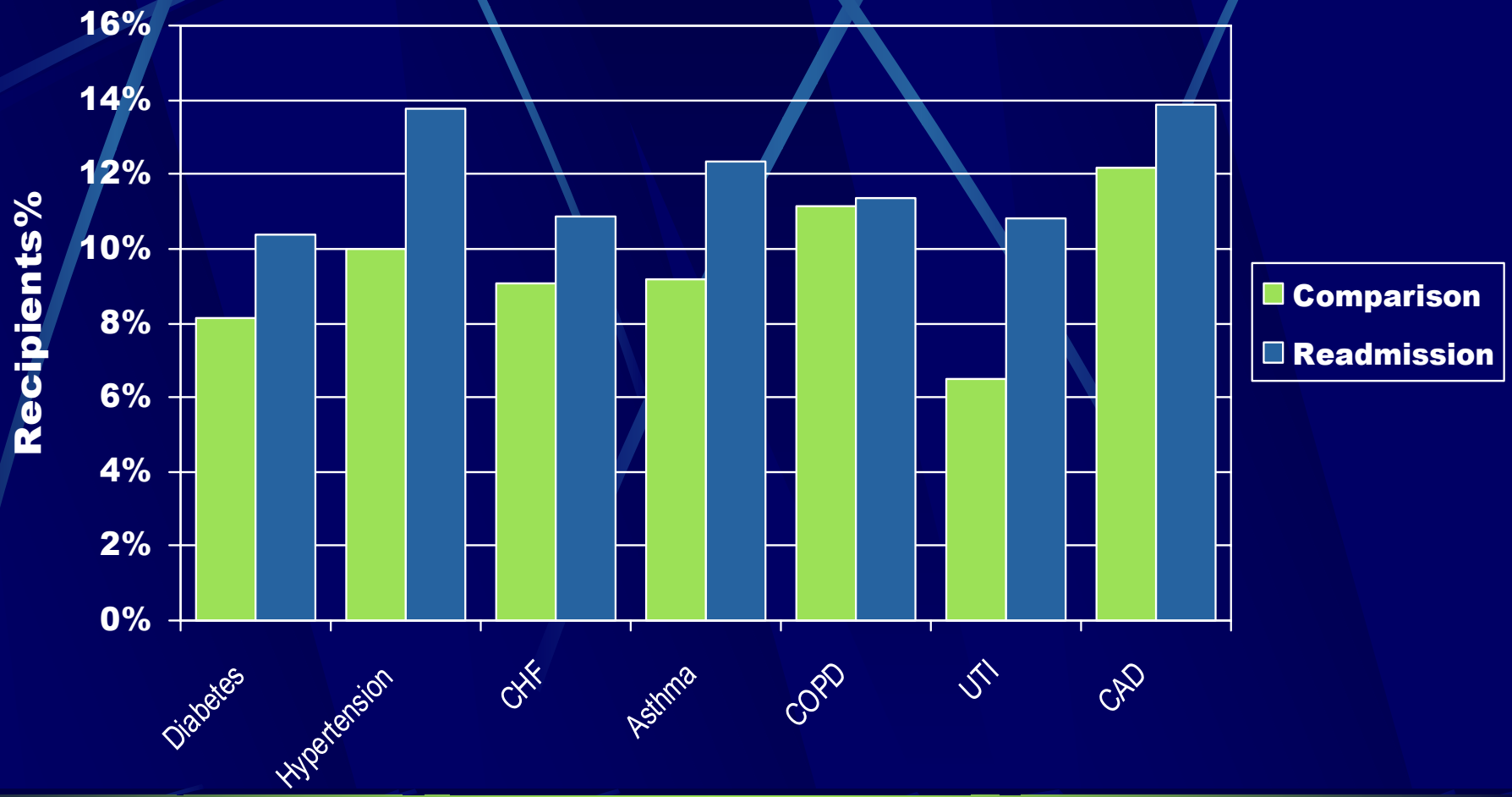

FIGURE 4. FREQUENCY OF RECIPIENTS WITHOUT OUTPATIENT PRESCRIPTIONS DISPENSED BEFORE INITIAL HOSPITALIZATION BY DISEASE CATEGORY FOR EACH STUDY GROUP

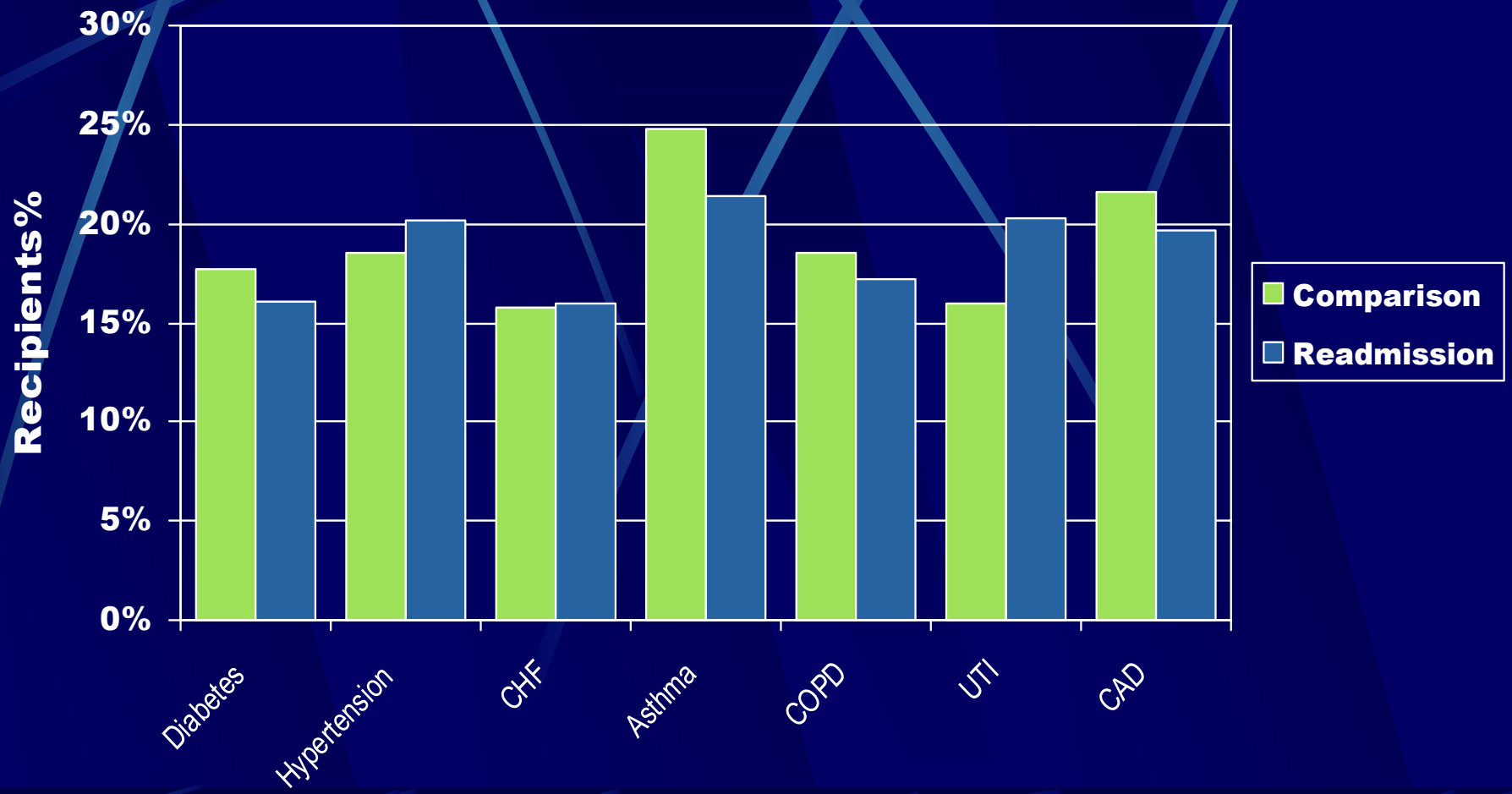

FIGURE 5. FREQUENCY OF RECIPIENTS WITHOUT OUTPATIENT PRESCRIPTIONS DISPENSED DURING INITIAL HOSPITALIZATION BY DISEASE CATEGORY FOR EACH STUDY GROUP

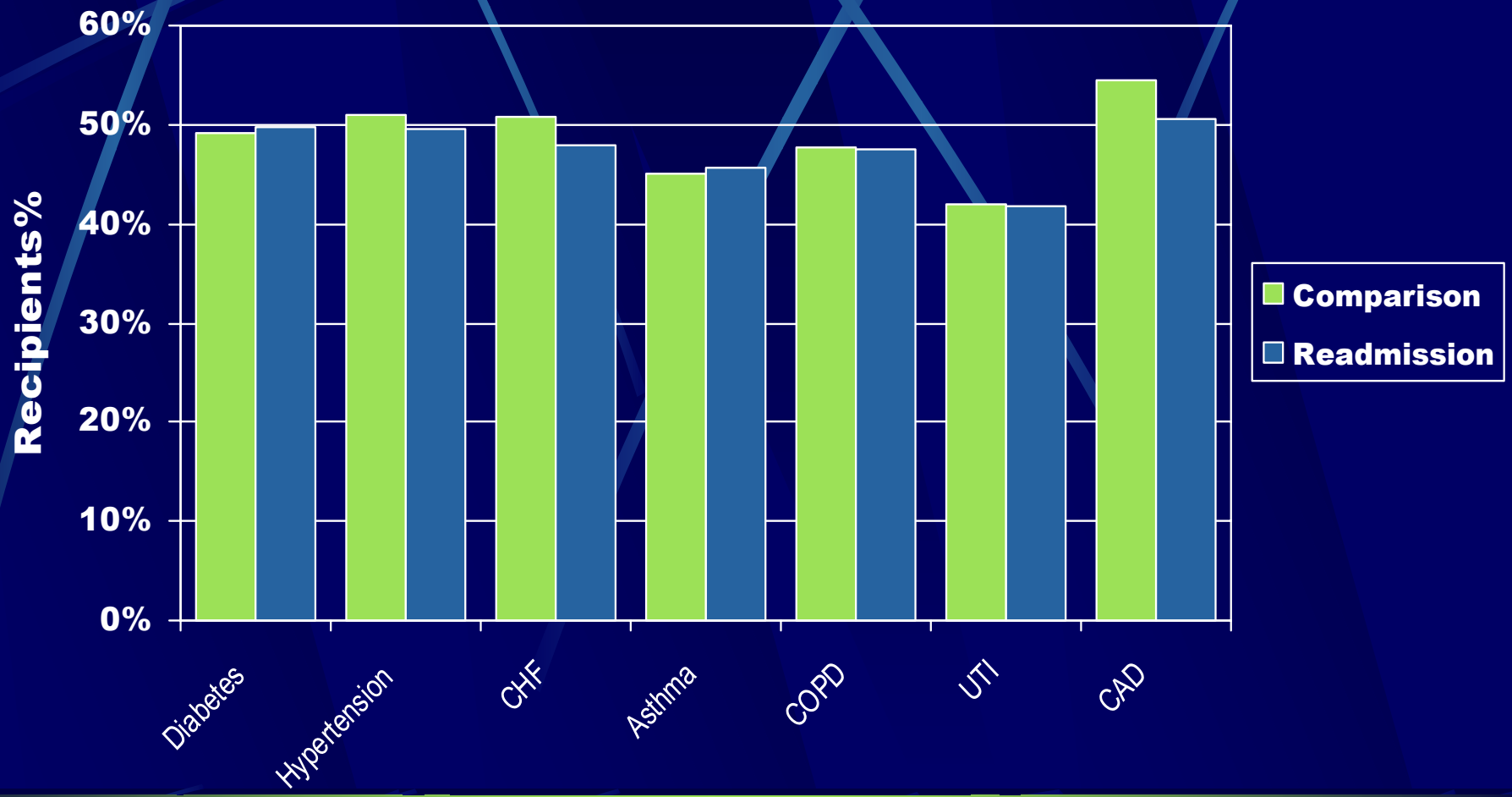

FIGURE 6. FREQUENCY OF RECIPIENTS WITHOUT OUTPATIENT PRESCRIPTIONS DISPENSED AFTER INITIAL HOSPITALIZATION BY DISEASE CATEGORY FOR EACH STUDY GROUP