

## Original Research

# Risk Factor Analysis of Hospital Readmissions at St. Petersburg General Hospital

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## Abstract

### Background

Decreased readmission rates are largely seen as an indicator of effective care and improved resource management. The case management team at St. Petersburg General Hospital in St. Petersburg, Florida identified chronic obstructive pulmonary disease (COPD) exacerbation, pneumonia, and sepsis as 3 of the leading diagnoses on index admission that later led to 30-day readmissions. By examining patients with these 3 diagnoses on index admission, we decided to investigate potential readmission risk factors including patient age, sex, race, body mass index (BMI), length of stay during the index admission, insurance type during index admission, discharge placement after index admission, coronary artery disease, heart failure, and type 2 diabetes.

### Methods

We conducted a retrospective study with data from 4180 patients at St. Petersburg General Hospital from 2016 through 2019 with index admission diagnoses of COPD exacerbation, pneumonia, and sepsis. A univariate analysis was conducted on patient sex, race, BMI, length of stay during the index admission, health insurance type during the index admission, discharge placement after the index admission, presence of coronary artery disease, presence of heart failure, and presence of type 2 diabetes. Subsequently, a bivariate analysis was run on these variables in relation to 30-day readmissions. Then a multivariable analysis was completed using binary logistic regression and pairwise analysis to determine the significance between variables within the categories of discharge disposition and insurance type.

### Results

Of the 4180 patients included in this study, 926 (22.2%) were readmitted within 30 days of discharge. In the bivariate analysis race, BMI, mean length of stay during the index admission, coronary artery disease, heart failure, and type 2 diabetes were not significantly associated with readmission. The bivariate analysis revealed that patients discharged to skilled nursing facilities had the highest readmission rates (28%), followed by home care (26%) ( $P = .001$ ). Medicaid patients (24%) and Medicare patients (23%) demonstrated higher readmission rates than those with private insurance (17%) ( $P = .001$ ). Readmitted patients were slightly younger (62.14 vs. 63.69 years;  $P = .02$ ) in the bivariate analysis. However, in the multivariable analysis, only patients with type 2 diabetes and patients with non-private insurance were associated with increased readmission rates. Pairwise analysis of the variables within insurance and discharge disposition categories demonstrates decreased readmission for individuals with Private/Other when compared to other insurance subtypes and decreased readmission for Other when compared to discharge disposition subtypes.

### Conclusion

Our data demonstrate that hospital readmissions are associated with a diagnosis of type 2 diabetes and having a non-private insurance status. Our findings lead us to suggest further investigation into changes in hospital policies and procedures for these groups that will aim to decrease readmission rates in the future.

**Keywords**

readmission/risk factors; 30-day readmission; chronic obstructive pulmonary disease; COPD; pneumonia; sepsis; health care costs; health disparities; insurance status; insurance type; type 2 diabetes mellitus

**Introduction**

Recurrent hospital readmissions adversely impact patient well-being as well as healthcare resource allocation. There are approximately 3.3 million readmissions in the United States (U.S.) each year, costing an estimated \$41 billion annually.<sup>1</sup> Government organizations have established programs to monitor hospital readmissions and attempt to decrease readmission rates. Specifically, Section 3025 of the Affordable Care Act directed the Department of Health and Human Services to implement the Hospital Readmissions Reduction Program (HRRP). Starting in October 2012, HRRP began to incentivize hospitals to improve discharge planning by reducing payments to hospitals with excess readmissions. Through HRRP, the Centers for Medicare and Medicaid Services (CMS) measures readmissions involving acute myocardial infarction, chronic obstructive pulmonary disease (COPD), heart failure, pneumonia, coronary artery bypass graft (CABG) surgery, and elective total hip arthroplasty and/or total knee arthroplasty. A study from 2010 to 2015 showed that the implementation of HRRP has significantly improved all-cause readmission rates for acute myocardial infarction, heart failure, and pneumonia.<sup>2</sup> This study also showed a modest improvement in admission rates for conditions that are not specifically targeted by HRRP.<sup>2</sup> The challenges of high readmission rates highlight the importance of identifying preventable factors that contribute to readmissions.

The case management team at St. Petersburg General Hospital (SPGH) in St. Petersburg, Florida identified several of the top index diagnoses leading to readmissions at SPGH. We used Medicare patient data compiled by the Health Services Advisory Group. Three index diagnoses that were the most prominently associated with readmissions at SPGH in 2017 and 2018 included acute exacerbation of COPD, pneumonia, and sepsis. The present study aims to analyze potential risk factors that may contribute to readmissions at SPGH by examining 30-day readmissions after index admissions for acute exacerbation of COPD, pneumonia, and sepsis.

COPD is the third leading cause of death in the U.S., with approximately 700 000 patients hospitalized for COPD annually.<sup>3</sup> COPD contributed to \$32 billion in direct healthcare costs in 2010 alone.<sup>3</sup> A literature review of COPD readmissions found that various factors including race, age, socioeconomic status, length of stay during the index admission, and comorbidities have discernible impacts on COPD readmission rates.<sup>4</sup> A 3-year retrospective study of 5 large hospitals in Canada showed that implementing a comprehensive case management program involving home visits, patient education, and proactive communication with outpatient primary care providers, lowered COPD admission rates.<sup>5</sup> This study yielded a decrease from 80.7% admissions with a primary diagnosis of COPD, prior to program implementation, to 62.8%, 2 years after program implementation.<sup>5</sup> Such programs demonstrate the possibility of curbing COPD admissions, and potentially readmission rates, by identifying weaknesses in the healthcare system and applying measures to address them.

Pneumonia is the second leading cause of readmission among the geriatric population.<sup>6</sup> Additionally, 30-day readmissions occur in approximately 17 to 25% of patients hospitalized for pneumonia, costing \$10 billion.<sup>7</sup> In a 2011 retrospective cohort study of patients in California, approximately 22.1% of patients hospitalized for pneumonia were readmitted within 30 days of discharge.<sup>6</sup> This study showed that readmission rates tended to be higher among female patients, and in patients with lower socioeconomic status, comorbidities, and acute organ failure.<sup>6</sup> The study excluded patients who died during their hospitalization but did not track post-discharge deaths within the 30-day window, which may have confounded the data.<sup>6</sup>

A systematic review analyzing existing pneumonia readmission risk prediction models showed that the predictive accuracy of these models at the individual level was modest.<sup>7</sup> However, these models corresponded to a clinically meaningful correlation in readmission risk when evaluating groups of patients.<sup>7</sup> This

review also noted that readmissions specifically related to pneumonia itself are uncommon, ranging from 2.6 to 7.2%.<sup>7</sup> These findings highlight the importance of pneumonia's impact on patients' comorbidities and general health as a potential cause for readmission.<sup>7</sup>

The pneumonia readmission rate for hospitalizations covered by Medicare decreased from 18.6% to 17.5% between 2009 and 2013, in part through targeted interventions motivated by financial penalties for excess readmissions levied by HRRP.<sup>7</sup> However, utilizing hospital-level and transitional care interventions for each patient with a diagnosis deemed high risk for readmission would not necessarily be cost effective. As such, determining reliable readmission predictors for patients with pneumonia and other high-risk diagnoses is necessary in order to provide hospital interventions to the appropriate patients; doing so will likely reduce readmissions while optimizing the use of healthcare resources.

Sepsis also plays a significant role in readmissions. Sepsis survivors have been shown to have many risk factors for readmission, including new cognitive impairment and functional disability after severe sepsis on index admission.<sup>1</sup> Congestive heart failure, pneumonia, sepsis, urinary tract infection (UTI), acute renal failure, and COPD were identified as the top 6 readmission diagnoses for patients previously admitted for sepsis.<sup>8</sup> These diagnoses accounted for 1 in 3 of all readmissions in a cohort study at 114 U.S. Veterans Administration hospitals, between 2009 and 2011.<sup>8</sup> Additionally, the study demonstrated that infection contributed to a larger portion of readmissions for patients discharged to skilled nursing facilities (25.0-27.1%), compared to readmission rates to those discharged home (16.8%).<sup>8</sup> The readmission diagnosis of sepsis was also found to account for 8.3% of readmissions among patients previously discharged to a skilled nursing facility who were originally admitted from a nursing facility, 8.2% of readmissions previously discharged to nursing facilities acutely, and 3.5% of readmissions previously discharged home.<sup>8</sup> These studies illustrate how comorbidities and discharge placement may significantly impact subsequent readmissions.

Identifying risk factors for readmission may provide significant benefits to both patients and the healthcare system as a whole. In the present study, we examined potential risk factors related to 30-day readmissions following some of the top readmission index diagnoses at SPGH, including COPD exacerbation, pneumonia, and sepsis. We analyzed potential medical, logistical, and socioeconomic risk factors. Specifically, we examined readmission rates in the context of age, sex, race, body mass index (BMI), length of stay during the index admission, health insurance type during the index admission, discharge placement after the index admission, and comorbidities such as coronary artery disease, type 2 diabetes, and heart failure. Our goal was to use these data to identify whether SPGH experienced increased readmissions from local skilled nursing facilities and to identify other factors for improvement in order to mitigate readmission rates.

## Methods

A retrospective chart review, using deidentified patient data from the HCA Healthcare database in accordance with HIPAA regulations, was performed for patients with 30-day readmission to SPGH between the dates of January 1, 2016 – December 31, 2019. Inclusion criteria for patient charts were age 20-100 years, associated diagnoses of acute exacerbation of COPD (ICD-10 J44.1), hospital-acquired pneumonia, community-acquired pneumonia, and aspiration pneumonia (ICD-10 J18.9, J69.0), sepsis, severe sepsis, and septic shock (ICD-10 codes falling under A41; R65.20, R65.21). The exclusion criterion was patient charts having the diagnosis of end-stage renal disease (ESRD) (ICD-10 N18.6).

To assess the relationships individually between all variables of interest in our data set and 30-day readmission, charts that met inclusion criteria underwent bivariate analyses for patient age, sex, race, BMI, length of stay during the index admission, health insurance type during the index admission, discharge placement after the index admission, coronary artery disease history, heart failure history, and type 2 diabetes history. A chi-square analysis was used for categorical variables, and the Welch two-sample t-test was used for continuous variables. To identify which of the variables of interest were independently associated with readmission, a

logistic regression analysis was performed to assess the impact of each variable on the odds of readmission. Pairwise comparisons were performed on the categories of health insurance type and discharge placement after the index admission to determine significance of variables within each category.

This study received an institutional IRB-ex-

empt determination (IRB approval number 2020-407).

## Results

A total of 4180 patients were included in the study. The breakdown of patient race is as follows: 84.1% White, 8% Black, 2% Asian, and 5% other. The study was based on medical records

**Table 1.** Impact of Response Variables on Hospital Readmission

Readmitted			
Variable	No	Yes	P-value*
Length of stay in days (mean)	6.26	6.32	.06
Body mass index (mean)	27.66	27.71	.88
Sex			
Male	1505 (78.0%)	424 (22.0%)	.83
Female	1749 (77.7%)	502 (22.3%)	
Race			
White	2734 (78%)	780 (22%)	.78
Black	268 (77%)	82 (23%)	
Asian	72 (81%)	17 (19%)	
Other/Unknown	180 (79%)	47 (21%)	
Coronary artery disease			
Yes	2665 (77%)	775 (23%)	.23
No	589 (80%)	151 (20%)	
Heart failure			
Yes	2616 (78%)	759 (22%)	.31
No	638 (79%)	167 (21%)	
Type 2 diabetes			
Yes	2357 (78%)	647 (22%)	.13
No	897 (76%)	279 (24%)	
Discharge disposition			
Home care	266 (74%)	92 (26%)	.001
Inpatient care	98 (78%)	28 (22%)	
Skilled nursing facility	579 (72%)	224 (28%)	
Routine discharge	1495 (76%)	464 (24%)	
Left against medical advice	150 (78%)	43 (22%)	
Other	666 (90%)	75 (10%)	
Insurance type			
Private/Other	540 (83%)	111 (17%)	.001
Self/Uninsured/Medicaid	771 (76%)	250 (24%)	
Medicare	1943 (77%)	565 (23%)	

Note: Welch's 2 sample t-tests were used to analyze continuous variables. Chi-squared tests were used to analyze categorical variables.

\*Significance level was set at  $P = .05$ .

that cited data only for White, Black, Asian, and "Other" patients. No other data were available. The mean age was 63.3 (interquartile range [IQR]: 52-77) years old with more females than males (53.9% vs. 46.1%). Of the 4180 patients who were originally diagnosed with pneumonia, COPD, or sepsis on index admission, 926 (22.2%) were readmitted within 30 days of discharge.

Readmission rates differed by race, but this difference was not significant (**Table 1**). The mean length of stay and BMI were similar for those who were readmitted and those who were not. Coronary artery disease, heart failure, and type

2 diabetes were not associated with readmission. However, patients discharged to a skilled nursing facility had the highest readmission rates (28%), followed by home care (26%) ( $P = .001$ ). Uninsured patients and those receiving Medicaid (24%), as well as those on Medicare (23%), had higher readmission rates compared to patients with private insurance (17%) ( $P = .001$ ) (**Table 1**).

In the multivariate logistic regression model, after adjusting for demographics and BMI, patients discharged to a skilled nursing facility were 21% (95% confidence interval [CI]: 0.97-1.49,  $P = .09$ ) more likely to be readmitted, and

**Table 2.** Logistic Regression Testing and Coefficients Assessing Predictors of Hospital Readmission

Independent variables	Adjusted odds ratio (95% CI)	P-value*
Length of stay in days	1.00 (0.99-1.01)	.56
Body mass index	0.99 (0.99-1.00)	.27
Sex		
Male	Referent	
Female	1.01 (0.87-1.17)	.93
Race		
White	Referent	
Black	0.97 (0.73-1.26)	.81
Asian	0.78 (0.44-1.32)	.38
Other/Unknown	0.86 (0.61-1.2)	.38
Discharge disposition		
Routine	Referent	
Inpatient	0.94 (0.6-1.45)	.8
Skilled nursing facility	1.21 (0.97-1.49)	.09
Home care	1.13 (0.86-1.48)	.38
Left against medical advice	0.85 (0.59-1.22)	.39
Other	0.37 (0.28-0.48)	.001
Insurance		
Private/Other	Referent	
Self/Uninsured/Medicaid	1.4 (1.08-1.82)	.01
Medicare	1.53 (1.19-1.97)	.001
Coronary artery disease: No	Referent	
Coronary artery disease: Yes	0.9 (0.73-1.11)	.31
Heart failure: No	Referent	
Heart failure: Yes	1.00 (0.81-1.22)	.99
Type 2 diabetes: No	Referent	
Type 2 diabetes: Yes	1.22 (1.03-1.46)	.02

\*Significance level was set at  $P = .05$ .

**Table 3.** Frequency of JCAHO Components Present in Discharge Summaries

Pairwise comparison	$\chi^2$	P-value*
Insurance		
Private/Other vs. Self/Uninsured/Medicaid	12.546	< .001
Private/Other vs. Medicare	8.896	< .001
Discharge		
Home vs. Other	44.249	< .0001
Inpatient vs. Other	13.929	< .001
SNF vs. Other	76.832	< .0001
AMA vs. Other	19.42	< .0001
Routine vs. Other	61.063	< .0001

Note: All pairwise comparisons not listed were not significant using Bonferroni correction for the family-wise error rate.

\*Significance level for the insurance category pairwise analysis was set at  $P = .0167$ . Significance level for discharge category was set at  $P = 0.0033$

those discharged to home care were 13% (95% CI: 0.86-1.48,  $P = .38$ ) more likely to be readmitted, but these results were not significant (**Table 2**). When examining insurance type, we found patients with a “Self/Uninsured/Medicaid” status to have higher odds of readmission (odds ratio [OR] = 1.40; 95% CI: 1.08-1.82,  $P = .01$ ) compared to patients with “Private/Other” insurance. Those with Medicare insurance were 53% more likely to be readmitted compared to those with private insurance (OR = 1.53; 95% CI: 1.19-1.97,  $P = .001$ ). Furthermore, patients with a Medicare insurance status had 53% greater odds of readmission on average than those with an insurance status of “Private/Other.” In the multivariate model, type 2 diabetes became a significant risk factor for readmission. Patients with type 2 diabetes had higher odds of readmission (OR = 1.22; 95% CI: 1.03-1.46,  $P = .02$ ) compared to their counterparts without type 2 diabetes (**Table 2**).

Pairwise analysis was performed on variables within the health insurance type and discharge placement categories. These results revealed that in the insurance type category, Private/Other had fewer readmissions than other categories and in the discharge placement category, Other had fewer readmissions (**Table 3**). The remaining comparisons not aforementioned were not found to be significant at their respective Bonferroni-corrected significance levels.

## Discussion

In this study, we evaluated the association of several factors with the 30-day readmission

rate for COPD exacerbation, pneumonia, and sepsis at SPGH. Broadly speaking, these factors can be characterized as medical or social factors. Previous research has demonstrated that hospital readmission rates are most often the result of chronic medical conditions that are associated with risk factors such as previous hospitalizations, extremes in age, and socioeconomic barriers.<sup>9,10</sup> The results of our study show that SPGH hospital readmission rates for the 3 conditions of focus were most affected by 2 key risk factors: patients with type 2 diabetes and patients without private insurance.

Prior studies have demonstrated that type 2 diabetes was associated with an increased risk of hospital readmission.<sup>10</sup> Other studies have noted that patients who were discharged from the hospital with a diagnosis of type 2 diabetes had a significantly higher 30-day readmission rate than patients without type 2 diabetes.<sup>11</sup> Inpatient education for patients regarding their type 2 diabetes is one potential way to mitigate possible readmissions.<sup>11</sup>

Additionally, multiple sociodemographic and socioeconomic factors have been demonstrated to impact readmission rates.<sup>13-15</sup> The results of our study revealed that a major risk factor for readmission was having Medicare, Medicaid, being self-pay, or being uninsured. Studies using data from the Nationwide Readmissions Database showed that implementation of the HRRP significantly decreased readmissions for not only Medicare patients, but also Medicaid patients, within target conditions including



acute myocardial infarction, heart failure, and pneumonia.<sup>14</sup> However, composite Medicaid readmissions still remained higher than those of Medicare post-HRRP.<sup>14</sup> These findings differ somewhat from our results, which demonstrated that the Medicare population had a stronger association with increased readmission risk compared to the Medicaid group. It should be noted that the data from our Medicaid group were combined with self-insured and uninsured populations. Regardless, our data still support the existing literature that shows individuals with government insurance (Medicare or Medicaid) tend to have increased readmission rates compared to those with commercial insurance.<sup>16</sup>

Interestingly, our study did not show increased readmission rates based on discharge disposition. In contrast, a study involving a cohort of 27 019 patients in Florida that initially completed a hip arthroplasty showed that patients discharged to skilled nursing facilities had more than twice the rates of readmission compared to patients discharged home with or without home healthcare.<sup>16</sup> These discrepancies may reflect the difference in study parameters as we examined different index diagnoses focused on medical as opposed to surgical issues. These differences may highlight an opportunity for further studies to examine whether discharge dispositions for different kinds of diagnoses significantly affect readmission rates.

Our study has several limitations. One limitation was the availability of discharge placement data. Once discharged from SPGH, patients have the option to transition to either home, a skilled nursing facility, a long-term acute care center, inpatient rehabilitation, and "other". "Other" consists of a combination of 20 other categories (including readmission with hospice and home with planned readmission within 72 hours) that are less commonly used; "Other" was found to be significantly associated with readmission in the pairwise analysis (**Table 3**). This result, however, may not be clinically relevant, because the "other" group contained multiple disparate dispositions (elopement, discharge with readmission for hospice care, etc). Another limitation is that data from SPGH's medical records were the only data available. SPGH is located in a metropolitan region and

patients readmitted to other facilities in the area would not have been captured in our data. Other limitations of our study include that our patients were primarily White (84.1%) and had Medicare (59.7%). Additionally, we focused only on the top 3 diagnoses associated with 30-day readmission rates at SPGH as opposed to other types or a broader collection of index diagnoses.

## Conclusion

In our retrospective study, we reviewed potential risk factors for 30-day readmissions at SPGH from the beginning of the year 2016 until the end of 2019 for patients originally admitted with COPD exacerbation, pneumonia, or sepsis. Potential risk factors that were included in our focus are medical comorbidities of coronary artery disease, heart failure, and type 2 diabetes. Additionally, socioeconomic and logistical factors associated with readmission included sex, race, BMI, length of stay during the index admission, discharge placement after the index admission, and insurance status during the index admission. A bivariate analysis was run on these variables separately. We also completed a multivariable logistic regression with selected covariates using a binary logistic regression. Our data ultimately revealed significant associations between increased 30-day readmission rates and type 2 diabetes and non-private insurance status.

In terms of quality improvement, the identified risk factors outlined by the results of this study can be used by clinicians and case managers to identify patients who are at higher risk for readmission. Improvements to strategies such as inpatient education regarding type 2 diabetes can be used to address medical risks. Other intensive strategies for those at higher risk for readmission due to social factors will be needed to reduce the risk of readmission. Examining and testing hospital interventions for uninsured patients and individuals with Medicare or Medicaid may be beneficial in helping understand and reduce readmission rates in the future. Future directions include expanding the risk factors being considered and expanding the data collection to include additional hospitals to capture a more varied population of patients who were readmitted to other hospitals.

### Conflicts of Interest

The authors declare that they have no conflicts of interest.

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