

# Evaluating Changes in Drivers of Hospital Readmissions at the Community Level

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## Abstract

**This study involved evaluation of the impact of drivers of changes in adult medicine readmission rates in the hospitals of Syracuse, New York. The study focused on this population because adult medicine readmissions were the largest source of medical-surgical and aggregate inpatient readmissions in the local hospitals. The study focused on identifying and correlating readmission rates for specific indicators over a twenty seven month period. Probably, the most important findings identified in the data were the high readmission rates for patients with high severity of illness and the strong correlations between readmission rates for these patients and total adult medicine readmission rates. Correlations between these readmission rates over the twenty seven month period exceeded 0.7000 for each of the hospitals. The study also identified readmission rates and correlations between rates for specific indicators including patient origin and chronic care diagnoses with readmission rates for all of adult medicine. The results of the study identified challenges facing hospital efforts to reduce readmissions including the need to provide alternative services for patients with high severity of illness and the need to address the impacts of multiple chronic diagnoses.**

## Keywords

**Hospital Readmissions, Hospitalization, Hospital Outcomes**

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## 1. Introduction

In the United States, the importance of containing health care costs continues to increase. Despite recent reductions in the rate of increase of these expenses, they continue to have a major impact on the cost of living [1] [2].

These developments have produced increased interest in the relationship between health care cost contain-

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ment and the improvement of patient outcomes, such as hospital readmissions. Historically, this outcome has been evaluated and used by individual providers as an indicator of the conditions of patients across inpatient stays [3] [4].

In recent years, the availability of hospital discharge data through federal and state data bases made it possible to define and analyze hospital readmissions for large populations. In the first decade of the twenty first century, the development of standardized definitions and computerized algorithms for these data made it possible to evaluate and manage these populations for large hospitals, communities, and regions [5] [6].

Increasing interest in the use of hospital readmission data has also been driven by the development of financial penalties for hospitals with excess inpatient readmissions by Medicare and other payers. The Medicare program was implemented in 2012 and has been expanded since that time to include additional diagnoses [7] [8]. Early analyses of data for hospitals have suggested that the program has contributed to reductions in readmissions [9] [10].

A major factor related to the development of data concerning hospital readmissions is the evaluation of risk for this outcome. Identification of drivers of hospital readmissions, whether clinical, demographic, or otherwise, is a key to reducing these outcomes. The need for a predictive model that can predict readmissions in large populations based on administrative data, combined with the development of readmission penalties by Medicare and other payors, has stimulated the development of research concerning this subject [11] [12]. Many researchers have concluded that most models for predicting hospital readmissions are of poor quality [13] [14].

## 2. Population

This study evaluated factors driving hospital readmissions in the metropolitan area of Syracuse, New York. This area includes three acute hospitals, Crouse Hospital (19,919 discharges excluding well newborns, 2014), St. Joseph's Hospital Health Center (25,532 discharges), and Upstate University Hospital (26,649 discharges). The hospitals work with combined medical staffs that include 1830 physicians and 12 nursing homes in the immediate service area. The Syracuse hospitals provide primary and secondary acute care services to a population of approximately 600,000 and a tertiary service area with a population of approximately 1,400,000.

Historically, the Syracuse hospitals competed while cooperating to improve the efficiency and outcomes of care in the service area. This cooperation has included the development of programs to address hospital readmissions through the Hospital Executive Council, their joint planning organization. In addition to addressing hospital readmissions, the Council has also functioned as a vehicle for improving hospital lengths of stay, coordinating emergency department resources, and reducing hospital inpatient complications in the community [15].

Beginning in 2011, the Syracuse hospitals and the Hospital Executive Council worked with 3 M Health Information Services (HIS) in the development of a program to reduce hospital inpatient readmissions. This program was based on use of the Potentially Preventable Readmissions software, developed by 3 M HIS. During 2006, the Hospital Executive Council provided input to the 3 M staff for the development of this software [16].

## 3. Method

This study evaluated factors driving hospital readmissions between January 2013 and March 2015 in the Syracuse hospitals. The study was based on hospital readmissions for adult medicine diagnoses. Historically, adult medicine patients have accounted for approximately 90 percent of inpatient readmissions for medical and surgical patients and approximately 70 percent of inpatient readmissions for all diagnoses in the Syracuse hospitals. The analysis was based on Potentially Preventable Readmissions identified through application of this algorithm to hospital administrative data by the Hospital Executive Council. This process resulted in the identification of each inpatient discharge as either an Initial Admission (IA) followed by at least one readmission within 30 days, an individual Readmission (RA) within 30 days, or an Only Admission (OA) not followed by a readmission within 30 days. Within the algorithm, all readmissions are based on definitions of clinical relationships between each Initial Admission and subsequent Readmission.

These data were used to calculate readmission rates for adult medicine and adult surgery patients. The numerators for these rates were identified by adult medicine and adult surgery readmissions (RAs) within 30 days. The denominators were identified as the sum of Readmissions (RAs), Initial Admissions (IAs), and Only Admissions (OAs). Adult medicine and adult surgery patients were identified using All Patients Refined Diagnosis Related Groups (APRDRGs).

The analysis for the study was developed using adult medicine readmission rates and readmission rates for each of the Syracuse hospitals for all payors. In order to evaluate changes in readmission rates, these data were developed by month for the period January 2013 - March 2015. For St. Joseph's Hospital Health Center, data for May 14 were estimated because this information was flawed by the introduction of an electronic medical record system during this period.

The initial component of the analysis focused on identification of changes in adult medicine readmission rates over time. It included definition of adult medicine readmission rates for each of the Syracuse hospitals by month for all payors. On the basis of monthly rates, numbers of cycles with declining rates were identified for each hospital. A declining rate cycle was identified as a consecutive series of months with progressively declining rates. On the basis of the monthly data, a Pearson correlation coefficient ( $r$ ) between the monthly rates and numbers of readmissions was calculated for each hospital.

The second component of the analysis focused on associations between aggregate adult medicine readmission rates and readmissions rates for adult medicine patients by severity of illness in the Syracuse hospitals. The Major and Extreme categories are the highest of four levels of severity of illness for hospital inpatients based on the All Patients Refined Diagnosis Related Groups (APRDRG) severity of illness system. The analysis for this component focused on identification of readmission rates and Pearson correlation coefficients for monthly aggregate and severity of illness specific readmission rates during the period of the study for each of the three hospitals.

The third component of the analysis focused on associations between aggregate adult medicine readmission rates and readmission rates for by source of admission in the Syracuse hospitals. The analysis involved sources of admission for patients readmitted from nursing homes and physician referrals, the most reliable indicators. The analysis involved identification of readmission rates and Pearson correlation coefficients for specific source of admission and monthly aggregate populations during the period of the study for each of the three hospitals.

The fourth component of the analysis focused on associations between aggregate adult readmission rates and readmission rates for medicine diagnoses that have been identified as major sources of readmissions in the literature and published research. These included heart failure (APRDRG 194), chronic obstructive pulmonary disease (APRDRG 140), and pneumonia (APRDRGs 138 and 139). The analysis involved readmission rates and Pearson correlation coefficients for monthly aggregate and specific diagnosis populations in the Syracuse hospitals during the period of the study.

## 4. Results

The first component of the study focused on monthly adult medicine readmission rates and numbers of readmissions for the Syracuse hospitals between January 2013 and March 2015. Relevant data are summarized in [Table 1](#).

This information demonstrated that adult medicine readmission rates for the period ranged between 10.16 percent for Crouse Hospital and 11.63 for St. Joseph's Hospital Health Center. These data suggested that between 10 and 12 percent of the adult medicine censuses of the hospitals involved patients readmitted within 30 days. The data also demonstrated that the total numbers of adult medicine readmissions ranged from, 1,941 at Crouse Hospital to 3,647 at St. Joseph's Hospital Health Center.

The data in [Table 1](#) demonstrated that monthly adult medicine readmission rates at each of the three Syracuse hospitals were cyclical because none of the hospitals was able to reduce these rates and sustain the reductions over long periods of time. Most of the cycles of reductions in rates lasted only two months. There were 5 - 7 of these cycles that included two months by hospital, 3 - 4 cycles that included three months by hospital, and 1 cycle for each of two hospitals that included four months or more.

These cycles, involving reduction of hospital readmissions over the 27 months of the study, were important because they included the variation in adult medicine readmission rates by hospital. These linear variations for total adult medicine readmissions were used in the rest of the study to evaluate the impact of potential drivers such as severity of illness, discharge status, and major chronic medicine diagnoses.

The second component of the study involved evaluation of the impact of severity of illness of readmitted patients on total adult medicine readmissions for the Syracuse hospitals. Relevant data are summarized in [Table 2](#).

The data in [Table 2](#) demonstrated that readmission rates increased with severity between January 2013 and March 2015. For each hospital, readmission rates for patients with Major and Extreme severity (15.24 - 17.34

**Table 1.** Potentially preventable readmissions, adult medicine, Syracuse hospitals.

	Crouse Hospital		St. Joseph's Hospital Health Center		Upstate University Hospital—SUNY UMU	
	Number of Readmissions	Readmission Rate	Number of Readmissions	Readmission Rate	Number of Readmissions	Readmission Rate
January 2013	83	10.64	136	10.89	112	9.51
February 2013	80	12.12	149	13.73	110	10.38
March 2013	71	10.14	142	12.07	113	9.94
April 2013	68	9.51	120	9.60	126	10.46
May 2013	84	10.85	140	11.21	119	10.30
June 2013	73	10.53	109	9.49	128	11.19
July 2013	67	9.22	136	11.17	127	11.24
August 2013	73	10.34	131	10.25	133	10.84
September 2013	60	9.52	154	13.56	116	11.10
October 2013	88	11.28	139	11.85	85	8.00
November 2013	60	8.88	128	11.63	93	10.41
December 2013	88	12.81	132	11.84	91	8.78
January 2014	70	10.13	126	11.27	89	8.33
February 2014	59	9.75	148	14.12	108	11.40
March 2014	64	9.44	129	11.52	121	12.05
April 2014	73	11.11	132	11.01	101	9.91
May 2014	72	9.69	137	11.01	98	9.19
June 2014	82	11.40	125	10.85	113	10.76
July 2014	72	9.55	121	10.51	126	11.32
August 2014	74	10.76	149	13.04	103	9.96
September 2014	65	8.89	133	11.69	108	10.89
October 2014	83	10.71	157	12.73	112	10.07
November 2014	56	8.64	129	11.83	102	10.53
December 2014	67	8.44	144	12.27	116	10.84
January 2015	75	10.30	135	11.95	137	12.49
February 2015	65	9.95	122	11.12	114	10.92
March 2015	69	9.76	144	12.59	143	12.32
Total	1,941	10.16	3,647	11.63	3,044	10.49
Number of Readmission Rate Cycles						
2 Months	5		5		7	
3 Months	4		3		2	
4 Months or More	1		1		0	

**Table 2.** Potentially preventable readmissions, adult medicine, Syracuse hospitals.

	Crouse Hospital		St. Joseph's Hospital Health Center		Upstate University Hospital—SUNY UMU	
	Number of Readmissions	Readmission Rate	Number of Readmissions	Readmission Rate	Number of Readmissions	Readmission Rate
Minor/Moderate Severity of Illness	671	6.23	1308	7.32	1296	7.20
Major Severity of Illness	882	13.71	1809	16.29	1296	15.05
Major/Extreme Severity of Illness	1270	15.24	2339	17.34	1748	15.85
Total	1941	10.16	3647	11.63	3044	10.49
Pearson Correlation Total Readmission Rate vs						
Total Readmissions	0.8287		0.8467		0.8295	
Minor/Moderate Severity of Illness Rate	0.3173		0.5620		0.5545	
Major Severity of Illness Rate	0.6259		0.7595		0.5073	
Major/Extreme Severity of Illness Rate	0.7187		0.8735		0.7278	

percent) were higher than the rates for patients with Minor and Moderate severity (6.23 - 7.32 percent). The data also demonstrated that, at each hospital, a majority of adult medicine patients who were readmitted were at Major or Extreme severity of illness.

The study data also identified positive and high Pearson correlations between numbers of adult medicine readmissions and adult medicine readmission rates by month among the hospitals (0.8295 - 0.8467). This was expected because of the relationship between these indicators and their populations.

The study data involving Pearson correlations between total adult medicine readmission rates and adult medicine readmission rates by severity of illness suggested the specific impacts of this indicator among the Syracuse hospitals over the 27 month period of the study. Correlations between adult medicine readmission rates for readmitted patients with minor and moderate severity and those for all adult medicine readmissions ranged from positive 0.3173 to 0.5620, while rates for readmitted patients with major and extreme severity and all adult medicine patients ranged from positive 0.7187 to 0.8735. These rates demonstrated a substantial impact of higher severity of illness through cyclical changes in readmissions for each of the hospitals.

Within these data, there were notable increases in correlation levels by hospital. For Crouse Hospital, the correlation between lower and higher severity of illness patients more than doubled from positive 0.3173 to 0.7187. For St. Joseph's Hospital Health Center, the readmission rate for higher severity of illness patients (0.8735) and total adult medicine patients was higher than the correlated between numbers of adult medicine readmissions and adult medicine readmission rates by month (0.8467). These data concerning patients with higher severity of illness underlined the impact of this indicator through the period of the study.

The third component of the analysis focused on the impact of source of admission on readmission rates for adult medicine in the Syracuse hospitals during the period of the study. Relevant data are summarized in [Table 3](#).

This information demonstrated that 80 - 93 percent of adult medicine readmissions originated as physician referrals from patients receiving care at home. These readmissions included patients at home referred to hospital emergency departments and subsequently readmitted, a common practice within the health care system of Syracuse. The remaining 7 - 20 percent involved patients transferred from nursing homes. The readmission rates for patients originating in nursing homes were substantially higher (23.08 - 30.38 percent) than those at home (11.86 - 13.11 percent), however, these patients accounted for a much smaller proportion of all adult medicine readmissions.

The data in [Table 3](#) also identified positive high Pearson correlation coefficients (0.8364 - 0.9265) between readmission rates for patients referred from home to the Syracuse hospitals and all adult medicine patients.

These levels probably resulted, at least in part, from the substantial majority of adult medicine readmissions for this source of admission. Correlations between readmitted patients originating in nursing homes and all adult medicine readmitted patients were positive but much lower (0.1791 - 0.1949).

In combination with the results of the previous analysis, these results suggested that a majority of patients readmitted to the hospitals resided at home and experienced high severity of illness. These individuals apparently experienced difficulties managing illnesses at home, sought care from physicians, and were subsequently admitted to hospitals.

The fourth component of the analysis focused on the impact of frequently encountered chronic care diagnoses on adult medicine readmission rates in the Syracuse hospitals between January 2013 and March 2015. Relevant data are summarized in **Table 4**.

**Table 3.** Potentially preventable readmissions, adult medicine, Syracuse hospitals.

	Crouse Hospital		St. Joseph’s Hospital Health Center		Upstate University Hospital—SUNY UMU	
	Number of Readmissions	Readmission Rate	Number of Readmissions	Readmission Rate	Number of Readmissions	Readmission Rate
Admit Source Nursing Home	102	23.08	295	28.67	339	30.38
Admit Source Physician/Home	1,812	11.86	3,231	13.00	2,448	13.11
Total	1,941	10.16	3,647	11.63	3,044	10.49
Pearson Correlation Total Readmission Rate vs						
Total Readmissions	0.8287		0.8467		0.8295	
Admit Source Nursing Home	0.1791		0.1796		0.1949	
Admit Source Physician/Home	0.9265		0.9076		0.8364	

**Table 4.** Potentially preventable readmissions, chronic care diagnoses, Syracuse hospitals.

	Crouse Hospital		St. Joseph’s Hospital Health Center		Upstate University Hospital—SUNY UMU	
	Number of Readmissions	Readmission Rate	Number of Readmissions	Readmission Rate	Number of Readmissions	Readmission Rate
Congestive Heart Failure (APR DRG 194)	174	21.97	419	24.53	210	23.49
Chronic Obstructive Pulmonary Disease (APR DRG 140)	63	11.62	192	14.88	98	16.12
Pneumonia (APR DRGs 138 - 139)	83	12.01	220	13.51	63	11.45
Total	1,941	10.16	3,647	11.63	3,044	10.49
Pearson Correlation Total Readmission Rate vs						
Total Readmissions	0.8287		0.8467		0.8295	
Congestive Heart Failure (APR DRG 194)	0.3482		0.3942		0.1395	
Chronic Obstructive Pulmonary Disease (APR DRG 140)	0.2662		0.3321		0.1418	
Pneumonia (APR DRGs 138 - 139)	0.1907		0.2336		0.3245	

The diagnoses for adult medicine readmissions that were evaluated in this component of the analysis have been used by Medicare and other payors to evaluate hospital performance. The study data evaluated the relationships between populations with these readmission diagnoses and those for all of adult medicine at each of the hospitals.

These data demonstrated that readmissions with a principal diagnosis of congestive heart failure produced the highest rates for the 27 month period in each of the Syracuse hospitals (21.97 - 24.53 percent). Patients with chronic obstructive pulmonary disease as a principal diagnosis accounted for the next highest rates at St. Joseph's Hospital Health Center and University Hospital (14.88 and 16.12 percent), while patients with pneumonia as a principal diagnosis accounted for the next highest rate at Crouse Hospital (12.01 percent).

The study data demonstrated that the degrees of correlation between monthly readmission rates and aggregate adult medicine readmission rates for adult medicine over the 27 month period of the study in each of the Syracuse hospitals were limited. At both St. Joseph's Hospital Health Center and Crouse Hospital, Pearson correlation coefficients ranged from 0.3942 - 0.3482 to congestive heart failure to 0.2336 - 0.1907 for pneumonia. At Upstate University Hospital, correlation coefficients ranged from 0.3245 for pneumonia to 0.1395 for congestive heart failure. All of these correlations were considerably below those generated by readmissions with high severity of illness and physician referrals from home in previous components of the study.

The limited extent of these correlations was produced, in part, by the limited numbers of readmissions accounted for by these diagnoses. Patients with congestive heart failure, chronic obstructive pulmonary disease, and pneumonia as principal diagnoses combined accounted for 12.2 percent of all adult medicine readmissions at Upstate University Hospital, 16.5 percent at Crouse Hospital, and 22.8 percent at St. Joseph's Hospital Health Center. None of these proportions for the chronic diagnoses combined exceeded one fourth of all adult medicine readmissions.

## 5. Discussion

This study focused on evaluation of the impact of potential drivers of adult medicine readmissions to hospitals in Syracuse, New York, a small metropolitan area with three relatively large hospitals. The study focused on adult medicine readmissions for all payors because this was the largest source of adult medical-surgical and aggregate inpatient readmissions in all of the hospitals. By identifying and correlating readmission rates over a 27 month period, the study was able to evaluate the impact of a number of factors on changes in this outcome.

The study data concerning aggregate adult medicine readmissions demonstrated that the Syracuse hospitals, like those in many communities, have had difficulty in sustaining reductions in readmissions over long periods of time. The data demonstrated that reductions in these rates over the 27 month period of the study were cyclical. Most involved declines in rates for two consecutive months, a few for three consecutive months, and two for four months or more.

The monthly data for hospital readmission rates over this interval proved to be a useful framework for the evaluation of potential drivers of hospital readmission rates. The correlations between readmission rates for individual indicators and aggregate rates evaluated associations that suggested the extent of cause and effect relationships.

In this context, the study identified high positive correlations between aggregate readmission rates and numbers of readmissions at all three hospitals. These were expected because of the relationships between the indicators.

Some of the most important findings in the study involved readmitted patients with high severity of illness. These patients accounted for some of the highest readmission rates in the study. Probably the most important relationships identified in the data were the strong correlations between rates for patients with high severity of illness and the total rates. Correlations between readmission rates by month over the 27 month period exceeded 0.700 in each of the hospitals. In one of the hospitals the correlation was 0.8735. These data demonstrated that high severity of illness patients were an important driver of adult medicine readmission rates at each hospital over the period of the study. With the exception of readmitted patients at home referred by physicians, this was the most important driver of changes in these rates identified in the study.

This conclusion suggests that efforts to reduce hospital readmissions should focus on patients with high severity of illness. At the same time, it raises the question of the extent to which rehospitalizations for these individuals with the highest levels of illness can be averted. This question is especially pertinent in a small metropolitan area such as Syracuse when relatively few alternatives to hospitalization are available for conditions than are too complicated for physician offices.

The results of the study also demonstrated that a number of populations produced relatively high readmission rates, but accounted for relatively small percentages of total adult readmissions and had relatively low correlations with the adult readmission data over the 27 month period of the study. These included readmissions for chronic conditions such as congestive heart failure, chronic obstructive pulmonary disease, and pneumonia, as well as readmissions from nursing homes. Correlations between the three diagnoses and those for adult medicine did not exceed 0.4000. Readmissions for the three diagnoses combined did not exceed 25 percent of those for adult medicine.

## 6. Conclusion

If the experiences of the Syracuse hospitals with inpatient readmissions identified in the study are typical, they suggest that addressing the drivers of inpatient readmissions will be a challenge from at least two different perspectives. Efforts to address the major drivers, high severity of illness, may be limited to long term approaches which delay this level of illness or avoid hospital admissions through palliative care. Efforts to address individual diagnoses will need to manage enough of these conditions to have a meaningful aggregate impact. All of these efforts will require the highest clinical management abilities that hospitals have to offer.

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