Factors Associated with the Difference in All-Cause Hospital Readmission Rates between Medicare Fee-for-Service and Medicare Advantage

By

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A dissertation submitted in partial fulfillment of

the requirements for the degree of

Doctor of Philosophy

(Population Health)

at the

UNIVERSITY OF WISCONSIN-MADISON

2019

Date of final oral examination: 12/11/2018

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Acknowledgements

I would like to graciously thank my family for their support and encouragement throughout my doctoral program. Thank you for believing in me and wanting the best for me. I would especially like to thank my parents whose love and guidance are with me in whatever I pursue. Most importantly, I would like to thank my loving wife, Jeong Ha, who provides endless support.

I thank Dr. John Mullahy for all his advice and guidance throughout my doctoral dissertation. His insightful suggestions and input have led my dissertation in a fruitful direction. He also advised me on how to live and prepare for the next steps in life. I would also like to give a special thanks to my dissertation committee, Dr. Maureen Smith, Dr. Mari Palta, and Dr. Andrea Gilmore-Bykovskyi for their support in completing my dissertation. No research is possible without infrastructure and requisite materials and resource. For this I extend thanks to the Health Innovation Program for preparing the data. Lastly, I thank Dr. Eva DuGoff for her guidance as a doctoral student. She trained me to become a better research and writer. As my teacher and mentor, she has taught me more than I could ever give her credit for here. She has shown me, by her example, what a good researcher should be.

Abstract

Hospital readmissions are costly, hard on patients and their families, and considered an indicator of inadequate inpatient care and discharge planning. Despite recent efforts to reduce readmissions in Medicare, a significant proportion of 30-day readmissions in Medicare is still considered avoidable. One possible way to identify opportunities to further reduce avoidable readmissions is by comparing Medicare Fee-for-Service (FFS) and Medicare Advantage (MA), the two-main programs for Medicare coverage, that could develop benchmarks for readmission rates and produce helpful information to identify opportunities to reduce readmissions.

Using the Wisconsin Health Information Organization all-payer claims data version 13 of the Data Mart and 2013 American Hospital Association's annual survey data, the specific aims of this dissertation and results are as follows:

The first study examines whether hospital readmission rates differ between Medicare FFS and MA among older adults within the same hospital. Based on conditional logistic regression models, the study shows that the odds of 30-day readmission in MA were 0.92 times lower than Medicare FFS within the same hospital (odds ratio, 0.92; 95% confidence interval (CI), 0.87-0.96). For 64 of 66 hospitals in Wisconsin, hospital-level readmission rates for MA were lower than those for Medicare FFS.

The second study examines whether the associations between Medicare programs and 30-day hospital readmissions vary by patients' number of chronic conditions. The overall predicted probability of readmission in Medicare FFS (14.9 percent) was 24 percent higher than that in MA (12 percent). The predicted probabilities of readmission increase as the number of chronic conditions increases in both Medicare programs. However, the direction and strength of

differences in the predicted probabilities of readmission between Medicare FFS and MA were not consistent across the number of conditions.

The third study compares the 7-day readmission rate by follow-up visits within 7 days and Medicare program. Forty percent of patients had a follow-up visit within 7 days after discharge in Medicare. The study shows that patients with follow-up visits within 7 days (2.5 percent) were associated with 46 percent lower readmission rate those without follow-up visits (4.6 percent). Also, while the difference in 7-day readmission rate between Medicare FFS and MA was statistically significant in the no follow-up visit group (Medicare FFS: 4.9 percent, MA: 3.7 percent, P<0.001), but not among patients with follow-up visits (Medicare FFS: 2.6 percent, MA: 2.2 percent, P=0.068).

Chapter 1: Overview

1.1 Introduction

Seventeen out of every 100 hospital discharges result in a subsequent hospital admission within 30 days in Medicare (Barrett, Wier, Jiang, & Steiner, 2015). Hospital readmissions in Medicare are estimated to cost $24 billion annually which accounts for 56 percent of total readmissions in the U.S. (Barrett et al., 2015; Hines, Barrett, Jiang, & Steiner, 2014; Jencks, Williams, & Coleman, 2009). Readmissions are costly, hard on patients and their families, and considered an indicator of inadequate inpatient care and discharge planning (G. F. Anderson & Steinberg, 1984; Fingar & Washington, 2015; Goldfield et al., 2008; McIlvennan, Eapen, & Allen, 2015). The Centers for Medicare & Medicaid Services (CMS) has undertaken several initiatives to reduce readmissions in Medicare, and the 30-day readmission rate declined from

17.7 percent in 2011 to 15.8 percent in 2016 in Medicare Fee-for-service (FFS) and from 12.6 percent in 2011 to 11.7 percent in 2014 in Medicare Advantage (MA; Health Care Cost Institute, 2014; MedPAC, 2018).

However, according to the Medicare Payment Advisory Commission's Report (2007), a large portion of readmissions in Medicare is still considered preventable. As such there is urgent need to identify further opportunities to reduce Medicare readmissions. Identifying factors that are associated with the difference between Medicare FFS and MA, the two main programs for Medicare coverage, could develop benchmarks for readmissions and related factors, and identify factors and patient groups for targeted improvement efforts. However, we have limited understanding about the factors related to the difference in readmission rates between Medicare FFS and MA.

Previous studies have found that readmission rates are higher in Medicare FFS than MA (America's Health Insurance Plans (AHIP), 2010; Lemieux, Sennett, Wang, Mulligan, & Bumbaugh, 2012). While substantial differences between MA and FFS that could affect readmission rates are well documented—e.g. beneficiaries in MA are known to be healthier and receive better care than Medicare FFS (Ayanian et al., 2013; Huckfeldt, Escarce, Rabideau, Karaca-Mandic, & Sood, 2017; Petterson et al., 2016; Timbie et al., 2017)—we have little information about whether the readmission rate difference between Medicare FFS and MA is due to differences in baseline health distributions, differences in the care, or some other factors.

Based on the Aday–Andersen Health Behavior Model, I expect that hospital characteristics, patient characteristics, and post-discharge care factors are important factors related to readmissions. Previous studies have found that the drivers of readmissions are multifactorial. Based on findings that hospital care practices vary by insurance (Spencer, Gaskin, & Roberts, 2013; Spencer, Roberts, & Gaskin, 2015), I consider that hospital care practices may differ between Medicare FFS and MA. Also, patient characteristics, such as having multiple chronic conditions, are associated with greater risk of readmission (Barnett, Hsu, & McWilliams, 2015). While the associations between outpatient care following discharge (such as post-discharge follow-up visits) and readmissions are inconclusive (Field, Ogarek, Garber, Reed, & Gurwitz, 2015; Hernandez, Greiner, Fonarow, & Al, 2010; Jackson, Shahsahebi, Wedlake, & DuBard, 2015; Kashiwagi, Burton, Kirkland, Cha, & Varkey, 2012; Sharma, Kuo, Freeman, Zhang, & Goodwin, 2010; Shen et al., 2017; Tung, Chang, Chang, & Yu, 2017), post-discharge outpatient follow-up visits have been promoted as a method of reducing readmission rates (Tung et al., 2017). However, previous studies have not examined how the relationship between patient, hospital, and outpatient-level factors and readmissions may vary between Medicare FFS and MA, and the association between readmissions and Medicare programs.

1.2 Objective and Specific Aims

The objective of this dissertation is to determine whether individual, hospital, and outpatient post-discharge factors are associated with 30-day readmission rate difference between Medicare FFS and MA among older adults. The dissertation identifies and prioritizes possible factors that could lead to readmission reductions in each Medicare program. These findings may help policymakers to develop policies and interventions to encourage Medicare, health plans, providers, and patients for better care to prevent unnecessary hospital readmissions.

Study Aim 1. Examine whether 30-day hospital readmission rates differ between Medicare FFS and MA within the same hospital (Chapter 2).

- Hypothesis 1. The likelihood of a hospital readmission within the same hospital will be lower among beneficiaries in MA than Medicare FFS.

Rationale. The *objective of this aim* is to identify the association between Medicare programs and the likelihood of a 30-day readmission within the same hospital. While evidence from previous studies shows that the readmission rate is lower in MA compared to Medicare FFS across hospitals (America's Health Insurance Plans (AHIP), 2010; Lemieux et al., 2012), little is known whether readmission rates vary between FFS and MA within the same hospital. This is important to improve our understanding about whether the quality of care during inpatient stays, including discharge process and transitional care which could affect readmission, differs by payer within the same hospital.

The ***hypothesis*** is that the likelihood of a hospital readmission within the same hospital will be lower among beneficiaries in MA than Medicare FFS. This hypothesis is supported by previous studies which suggest:

1) 30-day readmission rates are lower among MA beneficiaries than FFS beneficiaries across hospitals (America's Health Insurance Plans (AHIP), 2010; Lemieux et al., 2012);
2) MA beneficiaries were more likely to receive higher quality of care including care coordination and continuity of care than those in Medicare FFS (Ayanian et al., 2013; Huckfeldt et al., 2017; Petterson et al., 2016; Timbie et al., 2017);
3) People enrolled in private insurance were less likely to experience adverse health events including mortality than those in public insurance within the same hospital (Spencer et al., 2013, 2015);
4) Specific hospital characteristics such as teaching status, high staffing, not-for-profit status, size, and urban location are associated with higher quality of care (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007; Keeler et al., 1992; Vogeli, Kang, Landrum, Hasnain-Wynia, & Weissman, 2009). MA beneficiaries are more likely to be hospitalized at teaching, larger, and/or not-for-profit hospitals than those in Medicare FFS (Raetzman, Hines, Barrett, & Karaca, 2006).

Study Aim 2. Examine whether the number of chronic conditions moderates the relationship between Medicare programs (Medicare FFS and MA) and 30-day readmissions across hospitals. (Chapter 3)

- Hypothesis 2. The difference in the probability of readmission between Medicare FFS and MA will be larger among older adults with 2 or more chronic conditions compared to those

with 0 or 1 chronic conditions, but the difference will be attenuated as the number of chronic conditions increases.

Rationale. The *objective of this aim* is to identify whether the association between Medicare programs and the probability of readmission is moderated by the number of chronic conditions. Evidence from previous studies suggests that a greater number of chronic conditions is associated with higher risk of readmission. Patients with 6 or more chronic conditions account for nearly half of the readmission in Medicare FFS while they only account 14 percent of FFS beneficiaries (The Centers for Medicare & Medicaid Services, 2012), but there is little information on whether the association between Medicare programs and readmissions varies by the number of chronic conditions . This is crucial to identify whether the difference in readmission rates by Medicare program is due to differences in baseline health characteristics and/or in the services and quality of care by number of chronic conditions between Medicare FFS and MA.

The *hypothesis* is that the difference in readmission rates by Medicare program will be larger in beneficiaries with 2 or more chronic conditions compared to those with 0 or 1 chronic conditions. However, the difference will be attenuated as the number of chronic conditions increases. This hypothesis is based on evidence from previous studies:

1) Medicare FFS beneficiaries are more likely to readmitted to the hospital after discharge within 30 days than those in MA (America's Health Insurance Plans (AHIP), 2010; Lemieux et al., 2012);

2) Coordination of care is an important component of the management of chronic conditions and reduce readmissions (Brock et al., 2013; US Department of Health and Human Services, 2010);
3) It is known that MA provides better coordination of care and quality of care than Medicare FFS (Ayanian et al., 2013; Huckfeldt et al., 2017; Petterson et al., 2016; Timbie et al., 2017);
4) The difference in adverse health outcomes by different sociodemographic and health status groups attenuated as the number of chronic conditions increases (Lund Jensen et al., 2017; Tonelli et al., 2017);
5) Past studies have found that the benefit of treatment was smaller among sicker patients (Ghriwati et al., 2017; Muth et al., 2014).

Study Aim 3. Compare the 7-day readmission rate by outpatient follow-up visits within 7 days after discharge and by Medicare program. (Chapter 4)

- Hypothesis 3. Follow-up visits within 7 days after discharge will be associated with lower readmission rates than no follow-up visit.

Rationale. The *objective of this aim* is to first assess the association between follow-up visits within 7 days and readmissions in Medicare across hospitals. While follow-up visits within 7 days have been promoted as a method of reducing readmission rates, previous studies have shown inconclusive results. Identifying the association between follow-up visits within 7 days after discharge and readmissions is important to provide information about whether follow-up visits within 7 days should be considered as a method to reduce readmissions in Medicare.

The ***hypothesis*** is that follow-up visits will be associated with lower risk of readmission in Medicare. Evidence from previous studies supports this hypothesis:

1) Various professional societies promote physician follow-up visits after hospitalization discharge to reduce readmissions (Dreyer, 2014; Lin, Barnato, & Degenholtz, 2011);
2) Multiple transition of care models which are proven to reduce readmissions have implemented and promoted physician follow-up care (Dreyer, 2014; Hudali, Robinson, & Bhattarai, 2017).

1.3 Background and Significance

1.3.1 Importance of Reducing Hospital Readmissions in Medicare

Reducing hospital readmissions is an important way to improve health and quality of life, and lower health care spending (James, 2013). Readmissions are costly, hard on patients and their families, and considered an indicator of inadequate inpatient care and discharge planning (G. F. Anderson & Steinberg, 1984; Fingar & Washington, 2015; Goldfield et al., 2008; McIlvennan et al., 2015). Medicare accounts for 56 percent of total 30-day readmissions in U.S. with the highest readmission rate in 2013 (17.3 percent) compared to other payers such as private insurance (8.6 percent) and Medicaid (13.7 percent; Barrett et al., 2015). Health care spending on readmissions in FFS has increased from $17 billion in 2004 to $26 billion in 2013 (Hines et al., 2014; Jencks et al., 2009). Also, patients who experience a readmission are associated with greater risk for complications, hospital acquired infections, and stress (Fingar & Washington, 2015).

While not all readmissions could and/or should be prevented, according to a report from the Medicare Payment Advisory Commission (2007) more than 70 percent of readmissions in Medicare are considered potentially avoidable. These preventable readmissions are associated with $12 billion in Medicare spending and preventing even 10% of these readmissions could save Medicare at least $1 billion. Reducing readmissions in Medicare could also reduce the economic burden both in Medicare and U.S. health care system and improve patients' and families' health and quality of life. Thus, improving our understanding of ways to reduce readmission rates in Medicare is crucial to develop more effective, targeted intervention programs.

1.3.2 All-cause 30-day Readmission Rate Differences between Medicare Fee-for-Service and Medicare Advantage

Previous studies examined the readmission rate difference between Medicare FFS and MA focused on patients across hospitals (America's Health Insurance Plans, 2010; Lemieux et al., 2012; Oh, 2017). A report from America's Health Insurance Plans (2010) shows that 30-day, 90-day, and one-year readmission rates in MA were approximately 27-29 percent lower than those in FFS. Moreover, a study from Lemieux et al. (2012) reports that unadjusted 30-day readmission rates for patients in MA were nearly 25 percent lower than those in Medicare FFS. This study shows that while the readmission rate difference between Medicare FFS and MA narrowed after adjusting for comorbidity, the adjusted readmission rate in MA was still 15 percent lower than Medicare FFS.

However, these studies reflect a combination of differences in the hospitals where patients receive care, and in the care and service provided to patients within the same hospital. While recent studies have found that adverse patient safety events within the same hospital vary by source of coverage, we have limited evidence whether Medicare FFS and MA readmission rates within the same hospital vary (Spencer et al., 2013, 2015). Identifying whether the readmission rate between Medicare FFS and MA varies within the same hospital is important for providing evidence on the possible difference in the quality of care during inpatient stays, including discharge process and transitional care, which could affect readmission rates by payer type while using the same hospital. Also, comparing the associations between Medicare programs and readmission within and across hospitals could identify whether differences in the hospitals where patients obtain care contribute to readmission rate differences between Medicare FFS and MA.

1.3.3 Initiatives to Reduce 30-day Readmission Rate in Medicare

CMS has undertaken several initiatives to reduce hospital readmissions in Medicare FFS, especially during 2012-2013. The Hospital Readmissions Reduction Program (HRRP) was established in 2012. This program financially penalizes hospitals with relatively high rates of Medicare FFS readmissions. CMS focused on readmissions for heart attack, heart failure, and pneumonia at the beginning, and then added chronic obstructive pulmonary disease and elective hip or knee replacement in 2015 and coronary artery bypass graft in 2017. Under the HRRP, hospitals with readmission rates that exceed the national average are penalized by a reduction in payments across *all* their Medicare admissions—not just those which resulted in readmissions and not just those for the six targeted conditions. The penalty is a percentage of total Medicare

payments to the hospital and the maximum penalty was set at 1 percent for 2013, 2 percent for 2014, and 3 percent for 2015. According to a report in 2015 and 2017, 79 percent of the hospitals received more than a one-percent penalty, and 1.8 percent of hospitals received the maximum penalty (Boccuti & Casillas, 2016, 2017). While 21 percent of hospitals received no financial penalty, only 11 percent of Medicare patients used these hospitals (Boccuti & Casillas, 2016, 2017). However, 78 percent of Medicare patient admissions are projected to be in hospitals receiving either no readmission penalty or penalties of less than 1 percent of the hospital's Medicare inpatient payments. Fewer than 2 percent of Medicare patient admissions will be in hospitals receiving the maximum financial penalty. According to the Medicare Payment Advisory Commission, hospital readmission rates have fallen following implementation of HRRP and the introduction of HRRP did not have a negative impact on mortality rates (Wasfy et al., 2017).

Another program, the Hospital Value Based Purchase (VBP) program, was initiated in 2013 and was designed to encourage hospitals to improve the quality and safety of acute inpatient care by adjusting Medicare reimbursement. CMS used the reduced payments of participating hospitals' base fiscal year operating Medicare severity diagnosis-related group to fund the Hospital VBP Program. Under the Hospital VBP Program, CMS rewards acute-care hospitals with value-based incentive payments, based on 1) how well the hospitals perform on certain quality measures or 2) how much the hospitals' performance improves on certain quality measures from their performance during a baseline period. A hospital's performance is measured by the total performance score which is calculated based on measures from four domains

including safety, clinical care, efficiency and cost reduction, and patient and caregiver-centered experience of care/care coordination.

Also, CMS is implementing several accountable care organization (ACO) models including Medicare Shared Savings Program (MSSP), Pioneer ACOs, and Next Generation ACOs (NGACOs) Model. ACOs are groups of doctors, hospitals, and other health care providers who voluntarily work together to collaborate and share accountability for the quality and cost of the care delivered to their patients (Kaiser Family Foundation, 2016). Payments to ACOs incorporate varying levels of financial incentives based on shared savings or losses for performance on identified spending and quality measures including patient/caregiver experience, care coordination, patient safety. Few studies have examined the association between ACOs and hospital readmissions. One study have found that hospital affiliation with MSSP ACOs was associated with lower risk of readmissions following major surgeries (Borza et al., 2018), and another study have reported that hospitals affiliated with ACOs were able to reduce readmissions more quickly than other hospitals (Winblad, Mor, McHugh, & Rahman, 2017).

Also, the CMS introduced a pay-for-performance program in MA through the Quality Bonus Payment (QBP) program to encourage MA plans to provide high quality care to Medicare beneficiaries which could potentially reduce readmissions. The QBP program provides a five percent bonus payment to MA plans based on monthly per-member payments from Medicare that achieve at least a four-star rating on a five-star quality rating scale. The star ratings are based on more than 45 measures, across 9 categories, including all-cause readmission, overall rating of health care quality, and getting appointments and care quickly (The Centers for Medicare &

Medicaid Services, 2016). According to CMS, while 44 percent of MA contracts earned four or more stars in 2018 which decreased from 48 percent in 2017, nearly 73 percent of MA beneficiaries are in contracts with four or more stars, compared to about 69 percent of beneficiaries in in such contracts in 2017.

After these initiatives, the 30-day readmission rate declined from 17.7 percent in 2011 to 15.8 percent in 2016 in Medicare FFS and from 12.6 percent in 2011 to 11.7 percent in 2014 in MA (Health Care Cost Institute, 2014; MedPAC, 2018). However, considering readmissions are costly, hard on patients and their families (G. F. Anderson & Steinberg, 1984; Fingar & Washington, 2015; Goldfield et al., 2008; McIlvennan et al., 2015), and a still large number of readmissions are preventable (MedPAC, 2007), more efforts to achieve further readmissions reduction in Medicare is necessary.

1.3.4 Other Differences between Medicare Fee-for-Service and Medicare Advantage

Care and Management

Previous studies have found substantial differences between Medicare FFS and MA in the quality of care. MA beneficiaries are known to receive higher quality of care compared to those in Medicare FFS. Ayanian et al. (2013) have reported that MA beneficiaries were more likely to receive appropriate ambulatory quality of care than Medicare FFS beneficiaries based on breast cancer screening, diabetes care, and cholesterol testing for cardiovascular disease measures. Moreover, a recent study by Timbie et al. (2017) has found that MA outperformed Medicare FFS based on clinical quality care measures including diabetes care, cancer screening, and immunization measures. Recent studies by Spencer et al. (2013, 2015) suggest that within-

hospital differences in quality exist across payer types by identifying patients with public insurance including Medicare and Medicaid were more likely to experience adverse patient safety events within the same hospital compared to those enrolled in private insurance. While MA is not the same as private insurance, considering MA plans are offered and operated by private insurance companies, we might expect similar results for MA beneficiaries compared to private insurers.

Moreover, other studies have shown that MA is less likely to discharge their patients to post-acute care facilities and more likely to report shorter length of hospital stay compared to Medicare FFS. Mean length of hospital stay among patients in MA was 9.2 percent lower than those in Medicare FFS for medical services (Stocks & Steiner, 2015), patients in Medicare FFS were more likely to be discharges to post-acute care facilities as well as longer lengths of stay compared to those in MA (Huckfeldt et al., 2017). Also, MA plans are known to provide better coordination of care and continuity of care with approaches such as gatekeeping systems, robust information system, and network contracting, which could enhance the transitional care (G. Anderson, 2009; Better Medicare Alliance, 2017; Landon et al., 2012; Li et al., 2018). The difference in readmission rate by Medicare program could be attributed to the difference in the care and management by Medicare program.

Characteristics of Beneficiaries

Generally, MA beneficiaries are known to be healthier than Medicare FFS beneficiaries. This is due to the fact that MA plans have a stronger motivation to attract healthy beneficiaries according to the capitation payment system (McWilliams, Hsu, & Newhouse, 2012). The

capitation payment system encourages MA plans to attract people who have relatively low willingness-to-pay for health care services and who are potentially likely to use health care services less frequently (Boyd et al., 2005; Nicholson, Bundorf, Stein, & Polsky, 2004). Furthermore, sicker beneficiaries are known to prefer Medicare FFS for unrestricted access to providers (McWilliams et al., 2012). While the CMS applied adjustments in their payments to MA plans, there is still evidence that younger and healthier populations prefer switching into MA plans and previous studies have found that MA enrollees and new MA enrollees are more likely to report better health status than those in Medicare FFS (Mirel, Wheatcroft, Parker, & Makuc, 2012). Considering older, male, minority, and sicker patients were more likely to be readmitted in 30 days, differences in the characteristics of patients by Medicare program could explain the readmission rate difference between Medicare FFS and MA.

Hospitals and Providers

While Medicare FFS beneficiaries have access to any hospital and provider that accepts Medicare, MA plans are known to steer beneficiaries to a limited network of hospitals and providers, and typically require referrals for specialists (Gretchen, Ariel, & Neuman, 2016). Therefore, while Medicare beneficiaries generally rated MA lower on health care access than Medicare FFS, MA plans are known to provide better coordination care through the steered networks (Huckfeldt et al., 2017). Such variation in the access to providers and hospitals could explain readmission rate differences by Medicare program.

It is also known there is a difference in the characteristics of hospitals where MA and Medicare FFS patients are hospitalized. According to Raetzman, Hines, Barrett, and Karaca

(2006), MA patients are more likely to be hospitalized at teaching, larger, and/or not-for-profit hospitals than Medicare FFS patients. Hospital characteristics such as teaching status, staffing, not-for-profit status, size, and urban location are associated with higher quality of care (Kane et al., 2007; Keeler et al., 1992; Vogeli et al., 2009), and hospital characteristics such as teaching status (involving care for more complex patients), or hospitals with lower hospital staff level and hospitals in rural areas were associated with a higher risk of hospital readmission. As such differences in the characteristics of the hospitals where patients obtain care contributes to the difference in readmission rates between Medicare FFS and MA.

1.4 Data

This dissertation uses two datasets: the Wisconsin Health Information Organization (WHIO) all-payer claims data version 13 of the Data Mart (DMV13); and the 2013 American Hospital Association's (AHA) annual survey data.

WHIO is a state-wide collaboration of insurance companies, health care providers, large employers and public agencies. WHIO developed the state-wide health insurance claims database in 2005 to provide data useful for examining health care issues related to quality, efficiency and safety in Wisconsin. The data contain medical, dental, and pharmaceutical claims data with patient demographics from various payers including private insurance, Medicare, and Medicaid. WHIO is unique in that participation is voluntary, not state-owned and access to data is not government-controlled and collects large sets of administrative claims and eligibility data from WHIO members twice annually.

WHIO data for DMV13 includes medical claims data from October 2012 to December 2014 and covers 75 percent of the Wisconsin population (Wisconsin Department of Employee Trust Funds, 2015). In DMV13, Medicare claims account for 20 percent of the total claims, 38 percent are commercial claims, 20 percent are Medicaid fee-for-service claims, and 22 percent are Medicaid Health Maintenance Organization claims.

This study links the 2013 AHA annual survey data for hospital-specific information to WHIO by using the hospital identification number. AHA annual survey of hospitals is an annual survey of more than 6,400 hospitals in the US that collects data on variety of topics including hospital organizational structure, facilities and services, utilization data, physician arrangements, staffing, and community orientation. The survey, which is conducted in the fall of each year, asks hospitals to report data for the past 12-month operating period. Hospitals may complete the survey either online or by mailed questionnaire.

1.5 Summary

This dissertation examines patient-, hospital-, and outpatient-level factors in the context of Medicare programs and readmissions. The dissertation aims to improve our understanding of factors associated with the difference in readmission rates between Medicare FFS and MA among older adults to identify further opportunities to reduce readmissions in Medicare. Findings from this study could lead to further understanding of readmissions in Medicare to develop more effective and targeted intervention programs that could alleviate individuals and national burdens.

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Chapter 2

Medicare Advantage Patients Less Likely to have All-Cause 30-Day Readmission than Medicare Fee-for-Service Patients within the Same Hospital

ABSTRACT

Objective. To assess the extent to which all-cause 30-day readmission rate varies by Medicare program within the same hospitals.

Data Sources. Wisconsin Health Information Organization all payer claims database of 102,556 discharge records from 66 Wisconsin acute care hospitals between October 2013 and September 2014.

Methods. We used conditional logistic regression clustered by hospitals and generalized estimating equations across hospitals to compare the odds of unplanned all-cause 30-day readmission between Medicare Fee-for-Service (FFS) and Medicare Advantage (MA).

Principal Findings. The odds of 30-day readmission in MA were 0.92 times lower than Medicare FFS within the same hospital (odds ratio (OR), 0.92; 95% confidence interval (CI), 0.87-0.96) and across hospitals (OR, 0.91; 95% CI, 0.86-0.97). The adjusted overall readmission rate of Medicare FFS and MA were 14.9 percent and 12 percent, respectively. For 64 of 66 hospitals, hospital-level readmission rates for MA were lower than those for Medicare FFS.

Conclusion. Further efforts to improve the quality of inpatient and transitional care, and ensure all patients are receiving the same quality of care regardless of payer are needed. These findings also support the need to improve current monitoring systems in hospitals by including payer-specific data.

INTRODUCTION

Reducing hospital readmissions remains an urgent priority for national health policy in light of the detrimental influence on patient outcomes and care costs. Readmissions among Medicare beneficiaries account for 56 percent of 30-day readmissions in U.S. and cost $26 billion (James, 2013). To address this, the Centers for Medicare and Medicaid Services (CMS) has undertaken several initiatives to reduce readmissions among Medicare beneficiaries including the Hospital Readmissions Reduction Program (HRRP) in 2012. Following implementation of these initiatives, the 30-day readmission rate in Medicare Fee-for-service (FFS) declined from 19-19.5 percent during 2007-2011 to 17.5 percent in 2013, nationally (U.S. Department of Health & Human Services, 2014). However, considering that the Medicare Payment Advisory Commission (MedPAC, 2007) reported to the Congress that 76 percent of hospital readmissions in Medicare are considered potentially avoidable in 2007, more efforts to achieve further readmission reduction is necessary.

One possible way to identify opportunities to further reduce avoidable readmissions is by comparing Medicare FFS and Medicare Advantage (MA), the two-main programs for Medicare coverage, that could develop benchmarks for readmission rates and produce helpful information to identify opportunities to reduce readmissions. Specifically, comparing the risk of readmission between Medicare FFS and MA within the same hospital could produce important evidence on whether all patients are receiving the same quality of care during index hospitalizations regardless of payer type.

Substantial differences between MA and Medicare FFS could affect readmission rates. While several studies have documented that MA beneficiaries are known to receive higher quality of care than those in Medicare FFS, Medicare beneficiaries generally rated MA lower on

health care access than Medicare FFS (Ayanian et al., 2013; Petterson, Bazemore, Jabbarpour, & Wingrove, 2016; Timbie et al., 2017). Also, MA beneficiaries are more likely to be younger and healthier (Elliott, Haviland, Orr, Hambarsoomian, & Cleary, 2011; Timbie et al., 2017). Under capitation payment systems, MA plans have a strong motivation to attract younger and healthier beneficiaries. Conversely, beneficiaries' health risk factors can influence beneficiaries to select Medicare FFS over MA due to the less restrictive provider networks (Jacobs & Kronick, 2018). Moreover, MA plans can steer beneficiaries to a limited network of hospitals and providers (Gretchen, Ariel, & Neuman, 2016). Beneficiaries in MA are more hospitalized at teaching, larger, and/or not-for-profit hospitals than those in Medicare FFS (Raetzman, Hines, Barrett, & Karaca, 2006). However, it is unclear whether variations in readmission rate by payer type are attributable to the differences in hospitals and providers where patients receive care as well as the benefits from the limited network such as better coordination care and/or the services within hospitals.

Previous studies have found that the all-cause 30-day readmission rate in Medicare FFS ranges from 15-30 percent higher compared to MA (America's Health Insurance Plans (AHIP), 2010; Lemieux, Sennett, Wang, Mulligan, & Bumbaugh, 2012). However, these estimates reflect a combination of differences in the hospitals where patients receive care, and in the care and service provided to patients within the same hospital. While recent studies have found that adverse patient safety events within the same hospital differ by source of coverage, we have limited evidence whether risk of readmission within the same hospital differs between Medicare FFS and MA (Spencer, Gaskin, & Roberts, 2013; Spencer, Roberts, & Gaskin, 2015). Identifying whether the risk of readmission between Medicare FFS and MA differs within the same hospital is important for ascribing any difference in outcome to payer type, rather than to intrinsic

between-hospital variation, in quality of patient care including transitional care, which could affect readmission rates. Also, comparing the associations between Medicare programs and readmissions within and across hospitals could identify whether differences in the hospitals where patients obtain care contribute to readmission rate difference between Medicare FFS and MA.

Therefore, to address this need, this study examines variations in the risk of 30-day readmissions among Medicare FFS and MA beneficiaries within and across hospitals using Wisconsin Health Information Organization (WHIO) all-payer claims data (APCD), focusing on hospitalizations from October 2013 to September 2014. Ultimately this study hopes to provide helpful information to identify whether all patients are receiving same quality of care during index hospitalization to prevent readmissions regardless of type of Medicare program.

METHODS

Data Sources

This retrospective cohort study used the WHIO APCD version 13 of the data mart (DMV13) which includes medical claims data from October 2012 to December 2014 and covers 75 percent of the Wisconsin population. WHIO is a state-wide collaboration of insurance companies, health care providers, large employers and public agencies. WHIO developed the state-wide health insurance claims database in 2005 to provide data useful for examining health care issues related to quality, efficiency and safety in Wisconsin. The WHIO data contains medical, dental, and pharmaceutical claims data with patient demographics from various payers including private insurance, Medicare, and Medicaid. In DMV13, Medicare claims account for

20 percent of the total claims, 38 percent are commercial claims, 20 percent are Medicaid fee-for-service claims, and 22 percent are Medicaid Health Maintenance Organization claims.

We also used and linked the 2013 American Hospital Association's (AHA) annual survey data for hospital-specific information to WHIO by using the hospital identification number. The AHA annual Survey of Hospitals is an annual survey of more than 6,400 hospitals in the US that collects data on a variety of topics including hospital organizational structure, facilities and services, utilization data, physician arrangements, staffing, and community orientation.

Study Sample

This study focused on individuals aged 66 years or older at the time of index hospitalization, who were alive upon discharge, and hospitalized in an acute care hospital in Wisconsin. We included individuals continuously enrolled in the same Medicare program for the 12 months prior to the index admission, and continuously enrolled 30 days after discharge. This study excluded individuals with potentially incomplete data due to railroad benefits. Patients transferred to another acute care hospital upon discharge or discharged against medical advice were excluded from this study. Readmissions that are considered planned readmission were also excluded (Horwitz et al., 20011). Our study sample included 102,556 discharges from 66 hospitals.

Variables

Readmission. We used the 30-day all-cause hospital readmission measure developed for CMS by the Yale School of Medicine Center for Outcomes Research & Evaluation as the outcome in this study (The Centers for Medicare & Medicaid Services, 2016). Medicare beneficiaries age 66 or older who were hospitalized at a short-stay acute-care hospital and experienced an unplanned readmission for any cause to an acute care hospital within 30 days of discharge were defined as

readmitted. The measure uses a 30-day time frame because older adult patients are more vulnerable to adverse health outcomes during this time and also to be consistent with the readmission measures approved by the National Quality Forum and publicly reported by CMS. If there is more than one unplanned admission within 30 days of discharge from the index hospitalization, only the first is considered as a readmission.

Medicare Program. We focused on individuals enrolled in Medicare FFS and MA plans who are continuously enrolled in the same Medicare program for 12 months prior to the index hospitalization and 30 days after discharge from the index hospitalization. We define individuals continuously enrolled in Medicare Parts A as enrolled in Medicare FFS.

Covariates. We selected individual characteristics based on the health behavior model including (Aday & Andersen, 2005), predisposing factors (age, sex, and patient residence in a rural area) and need characteristics (principle diagnosis for index hospitalization based on major diagnostic categories, length of stay for index hospitalization, discharge location, hospice status, patient-level number of chronic conditions, number of hospitalizations and average days of hospitalization in 12 months prior to index hospitalization).

We included hospital characteristics (teaching status, size, urban/rural location, type, Medicaid inpatient, and staff level) to examine the overall association between Medicare programs and readmissions across hospitals. Appendix 1 provides a list of covariate categories.

Statistical Analysis

We compared baseline characteristics of hospitalizations stratified by Medicare program. Additionally, the percentage of total readmissions by the number of days after discharge and by Medicare program were examined to observe how the distribution of readmissions within the 30-day timeframe varies by Medicare program. Next, we used conditional logistic regression

stratifying by hospitals to examine the association between Medicare programs and 30-day readmissions within hospitals. Generalized estimating equations (GEE) with independent working correlation were used to perform multivariate logistic regression estimation to examine the association between Medicare programs and 30-day readmissions across hospitals. Statistical significance was set at $p<0.05$. Using the multivariate logistic regression model, we calculated the mean predicted probabilities of readmission by Medicare program and hospital. Analyses were conducted in R Studio 3.3.2 using the 'geem' and 'clogit' package.[i]

We also performed sensitivity tests to examine the robustness of our results. Specifically, we examined the models with all-cause 3- and 7-day readmissions, which may more directly reflect associations with inpatient care. Also, as CMS does not reimburse readmissions within 24 hours after discharge for the same condition (Jencks, Williams, & Coleman, 2009), we ran our analyses based on readmissions between 2 through 30 days from date of discharge. Next, considering that the use of post-acute care facilities varies by Medicare program (Kumar et al., 2018), there could be an indirect association between Medicare programs and readmissions through discharge location and hospice status. Therefore, we examined the association between Medicare programs and readmissions without adjustment for discharge location and hospice status. Lastly, according to the Agency of Healthcare Research and Quality, hospitals with fewer than 30 discharges are not recommended to use in comparative analyses (Spencer et al., 2013). As we are comparing Medicare FFS and MA within the same hospital, we applied the sample exclusion criteria for each Medicare programs in hospitals for a reliable comparison between Medicare FFS and MA.

[i] We separately ran the main analysis with the propensity score method based on inverse probability of treatment weighting (IPTW) to adjust for selection bias. However, we found no difference in the study results between analyses with and without the propensity score method.

RESULTS

The baseline characteristics of 102,556 discharges by Medicare program are shown in Table 1. Between October 1, 2013 and September 30, 2014, nearly three out of four discharges were from patients in Medicare FFS and the other one out of four discharges were from patients in MA. The Medicare FFS sample was more likely to be older (85 years or older - FFS: 26.9%, MA: 21.7%), have a longer stay for their index hospitalizations (4 or more stays – FFS: 47.1%; MA: 42.7%), and have a greater number of chronic conditions (6 or more – FFS: 31.2%; MA: 20.9%). While patients in Medicare FFS were more likely to be discharged to a skilled nursing facility (FFS: 27.9%; MA: 19.6%), patients in MA were more likely to discharged to home (FFS: 69.8%; MA: 76.1%).

Figure 1 displays the distribution of the readmissions by number of days after discharge and by Medicare program. Generally, the percentage of readmissions decreases as the number of days after discharge increases starting from the second day. The percentage of readmissions for the first day after discharge in Medicare FFS is nearly half than that of MA, and nearly 0.2 times lower than that of the second day in Medicare FFS. In both Medicare programs, more than 30 percent of the readmissions occur within the first 7 days after discharge.

Table 2 reports unadjusted and adjusted odds ratios (OR) from our logistic regression models. The results from the conditional logistic regression models show the unadjusted odds for readmission (Unadjusted) in MA were 0.84 times lower than Medicare FFS (OR, 0.84; 95% CI, 0.80-0.88; P<0.001). While controlling for characteristics such as age, gender, and rural/urban (model 1) shows similar result to the unadjusted model (OR, 0.83; 95% CI, 0.79-0.87; P<0.001), adding need characteristics (model 2) including the number of chronic conditions narrows the

difference in odds for readmission between MA and FFS (OR, 0.92; 95% CI, 0.87-0.96; P<0.001).

The results from the logistic regression models with GEE show similar results to the conditional logistic regression models. The odds for readmission in MA were 0.81 times lower than FFS in the unadjusted model (OR, 0.81; 95% CI, 0.77-0.86; P<0.001) and adjusting for need characteristics (model 2) narrows the difference in odds for readmission between MA and FFS within the same hospital (OR, 0.92; 95% CI, 0.86-0.98; P=0.007). The final model (model 3), adjusted for individual and hospital characteristics, reports a similar odds ratio to model 2 (OR, 0.91; 95% CI, 0.8-0.97; P=0.003).

Figure 2 shows the adjusted overall readmission rates and adjusted hospital-level readmission rates by Medicare program. The adjusted overall readmission rate of Medicare FFS and MA were 14.9 percent and 12 percent, respectively. For 64 of 66 hospitals, we find that hospitals' readmission rates for MA were lower than those for Medicare FFS. Hospital-level adjusted readmission rates range from 4 to 21.6 percent in MA and 5.1 to 38.6 percent in Medicare FFS. Among hospitals where the readmission rate was lower in MA than in Medicare FFS, the hospital-level readmission rates for Medicare FFS were 1.03 to 3.49 times higher than those for MA.

Results of sensitivity analyses were qualitatively consistent to the main analysis (Appendixes 2-3). Especially, the results show that MA was associated with lower odds of readmission than Medicare FFS with both 7-day readmission measure (OR, 0.90; 95% CI, 0.82-0.97) and 3-day readmission measure (OR, 0.83; 95% CI, 0.73-0.95).

DISCUSSION

Our study findings contribute new and relevant information to the literature, as previous literature have not adequately controlled for difference in access and use of hospitals between Medicare FFS and MA in the context of all-cause 30-day readmissions. In our analysis, we find that patients in Medicare FFS were more likely to be readmitted within 30-days after discharge compared to those in MA when they used the same hospital. Also, the study results show hospital-level adjusted readmission rates were higher in Medicare FFS than MA in 50 of the 51 hospitals. These results suggest that older adults in Medicare FFS face higher risk of readmission compared to those in MA, despite using the same hospital.

The results from this study are in line with previous studies suggesting that the readmission rate in Medicare FFS is higher than in MA. Lemieux et al. (2012) have reported that 30-day readmission rates for patients in MA were nearly 13-20 percent lower than those in Medicare FFS. Also, according to a report from America's Health Insurance Plans (2010), 30-day, 90-day, and one-year readmission rates were about 27-29 percent lower in MA than in Medicare FFS. Our study extends this literature by examining whether the readmission rate between Medicare FFS and MA differs even when patients use the same hospital. Assessing whether readmission rates are different within the same hospital by payer type is important to improve our understanding around the risk of readmission and identify whether patients are receiving the same quality of care. Furthermore, it produces information on whether current monitoring system for quality of care in Medicare could be improved to provide more helpful information to Medicare beneficiaries.

Previous studies examined the readmission rate difference between Medicare FFS and MA focused on patients across hospitals (America's Health Insurance Plans, 2010; Lemieux et

al., 2012; Oh, 2017). Considering MA patients are more likely to be hospitalized at teaching, larger, and/or not-for-profit hospitals than Medicare FFS patients (Raetzman et al., 2006), there are possibilities that differences in the hospital characteristics where patients obtain care contributes to the difference in readmission rate by Medicare program. The difference in quality of care and health outcomes by hospital characteristics are well documented in that hospital characteristics such as teaching and not-for-profit hospital, high staffing hospitals, and/or larger and urban hospitals are known to be associated with higher quality of care (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007; Keeler et al., 1992; Vogeli, Kang, Landrum, Hasnain-Wynia, & Weissman, 2009). The narrowed difference in the odds of readmission between Medicare FFS and MA in the unadjusted conditional logistic regression model compared to the unadjusted GEE model implies the difference in hospitals where patients receive care attributes to the readmission rate difference by Medicare program. However, we could find no difference due to hospitals after adjusting for patients' characteristics according to similar results from the three models (i.e., the GEE model adjusted for only individual characteristics, the GEE model adjusted for both individual and hospital characteristics, and the conditional logistic regression model adjusted for individual characteristics).

Possible differences in the unmeasured health characteristics between Medicare FFS and MA could explain some of the difference in the risk of readmission by Medicare program within the same hospital. This study results show that adding adjustment for need characteristics including number of chronic conditions and principle diagnosis for initial hospitalization narrows the difference in odds for readmission between Medicare FFS and MA. Considering this study used administrative data, there could be unmeasured health characteristics such as functional limitation that are associated with readmission risk. Such characteristics could vary among

patients between Medicare FFS and MA. Therefore, further adjustment for health characteristics could partially explain the difference in risk of readmission between Medicare FFS and MA within the same hospital.

Also, the difference in the risk of readmission between Medicare FFS and MA within the same hospital could be explained by differences in quality of care during index hospitalizations, including but not limited to discharge processes and transitional care. It is known that high quality of inpatient and transitional care are important components to reduce readmissions. Friedman et al. (2009) have found that hospitalized patients who experienced adverse safety events had higher risk of readmission. Also, interventions to improve the discharge process and transitional care including Project Re-Engineered Discharge and Project Better Outcomes for Older adults through Safe Transitions are known to be associated with lower risk of readmission (Bradley et al., 2013; Hansen et al., 2013, 2011). Furthermore, recent models which encourage providers to manage care coordination and other factors affecting risk of readmission, such as accountable care organizations, are effective in reducing readmissions (Borza et al., 2018; Winblad, Mor, McHugh, & Rahman, 2017).

To our knowledge, there is no study which has directly examined whether the quality of inpatient care and transitional care differs between Medicare FFS and MA, but there are several considerations that support this. MA beneficiaries are known to receive higher quality of care than those in Medicare FFS. Ayanian et al. (2013) have reported that MA beneficiaries were more likely to receive appropriate ambulatory quality of care than Medicare FFS beneficiaries based on breast cancer screening, diabetes care, and cholesterol testing for cardiovascular disease measures. Moreover, a recent study by Timbie et al. (2017) has found that MA outperformed Medicare FFS based on clinical quality care measures including diabetes care, cancer screening,

and immunization measures. Also, MA plans are anticipated to provide better coordination of care and continuity of care with approaches such as gatekeeping system, robust information system, and network contracting (Anderson, 2009; Better Medicare Alliance, 2017; Landon et al., 2012; Li et al., 2018). Considering MA plans provide better coordination of care services, which could enhance the transitional care, than Medicare FFS, there could be a difference in the risk of readmission by Medicare program while patients use the same hospital. Recent studies by Spencer et al. (2013, 2015) suggest that within-hospital differences in quality exist across payer types by identifying patients with public insurance including Medicare and Medicaid were more likely to experience adverse patient safety events within the same hospital compared to those enrolled in private insurance. While MA is not the same as private insurance, considering MA plans are offered and operated by private insurance companies, we might expect similar results for MA beneficiaries as for private insurers.

There are also external factors after discharge that could affect the risk of readmission despite patients in different Medicare programs receiving the same quality of care within the same hospital. Previous studies have found that factors such as lack of social support, living situation, and community and neighborhood factors are associated with the risk of readmission. These could be considered as non-medical factors outside of hospitals' control (Calvillo–King et al., 2013; Herrin et al., 2015; Kind et al., 2014). However, our further analyses based on all-cause 3- and 7-day readmissions, which may more directly reflect associations with inpatient care, supports the possibility that the difference in quality of care by Medicare program within the same hospital contributes to the difference in readmission risks between different payers. Considering the similar and bigger differences in the risk of 3- and 7-day readmissions between Medicare FFS and MA (Appendix 2) compared to 30-day readmissions, and that more than 30

percent of readmissions occur in the 7-day time frame after discharge, it seems there are substantial opportunities to achieve further readmissions reduction by improving the quality of inpatient and transitional care. Additional studies to directly examine whether there is difference in quality of inpatient and transitional care, between Medicare FFS and MA and whether those differences explain the difference in readmission rates will be needed to develop methods to reduce readmissions rate.

Moreover, this study shows that hospital-level readmission rates for MA were lower than those for Medicare FFS in all but two of the 66 hospitals in Wisconsin. However, there is variance in the readmission rate difference between Medicare FFS and MA across hospitals. The readmission rates of hospitals were 1.03 to 3.49 times higher in Medicare FFS compared to MA. Future studies to examine factors and characteristics related to the variance in readmission rate difference by Medicare program across hospitals will be helpful to identify opportunities to not only reduce readmissions but also reduce the gap by Medicare program.

This study has the following limitations. First, the primary limitation of this analysis is the use of administrative data. Because administrative data have limited clinical information, there could be unmeasured factors that influence readmissions. We tried to overcome this limitation by including principle diagnosis for index hospitalization, patient-level number of chronic conditions, number of hospitalizations in the baseline period, and days hospitalized in 12 months prior to index hospitalization. Moreover, the data have no information on race/ethnicity. Next, this study is based on Wisconsin data, thus the results may not be generalizable to other states. Wisconsin has such unique characteristics including a relatively higher proportion of provider-owned health plans. However, considering Medicare is a federal program and majority of MA plans operate in multiple states (Gold, Jacobson, Damico, & Neuman, 2013), the study

findings provide useful information to Medicare and MA health plans. Third, this analysis focused on data in the early years of several initiatives that CMS undertaken such as the Medicare Hospital Readmission Reduction Program, therefore may not reflect the full effect of these initiatives. Lastly, we could not remove all planned readmissions with perfect accuracy using these data. However, by using the Yale formulation of all-cause readmission (a method widely accepted by providers and payers) we were able to eliminate many types of planned readmissions.

In conclusion, this study presents evidence that risk of readmission is higher among Medicare FFS beneficiaries than among those compared to those in MA within and across hospitals in Wisconsin. CMS has undertaken several initiatives to reduce readmissions in Medicare such as Hospital Readmissions Reduction Program in 2012. While these efforts contribute to readmission reduction, this study indicates that further efforts in improving the quality of care and reducing gap in the care by payer type could lead to further reductions in readmissions. Additional studies to identify factors and healthcare services that cause differences in quality of care related to readmissions by Medicare program will be helpful for policy makers to develop strategies and incentives that influence hospitals, providers, and patients. Our study findings also support the need to improve current monitoring systems for hospitals by including payer-specific data that could increase the transparency of hospital care and help consumers choose care venues.

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Table 1. Characteristics of Discharges by Medicare Program, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (N=102,556).

	Overall	FFS	MA	P-Value
N	102,556	77,237	25,319	
Age (%)				<0.001
66-69	16.4	16.3	16.8	
70-74	19.6	19	21.3	
75-79	19.6	19.1	21	
80-84	18.8	18.6	19.2	
85-89	13.3	13.5	12.4	
90+	12.4	13.4	9.3	
Gender = Female (%)	57.3	58.4	53.8	<0.001
Residence = Rural (%)	13	12.5	14.3	<0.001
Hospice = Hospice (%)	2.6	3.4	0	<0.001
Length of Stay (%)				<0.001
0-1	11.1	10.3	13.3	
2-3	42.9	42.5	43.9	
4-5	23.2	23.7	21.5	
6 or longer	22.9	23.4	21.2	
Number of Hospitalizations[a] (mean (sd))	0.86 (1.37)	0.90 (1.41)	0.76 (1.24)	<0.001
Avg Days of Hospitalizations[b] (mean (sd))	2.32 (4.39)	2.36 (4.12)	2.20 (5.12)	<0.001
Discharge Location/Service (%)				<0.001
Home	71.3	69.8	76.1	
SNF	25.9	27.9	19.6	
Rehab	2.8	2.3	4.3	
Number of Chronic Conditions (%)				<0.001
0-1	18.4	16.8	23.4	
2-3	29.2	27.9	32.9	
4-5	23.7	24	22.8	
6-7	15.8	16.8	12.8	
8-9	8.4	9.3	5.6	
10 or more	4.5	5.1	2.5	
Principle Diagnosis for Index Hospitalization (%)				<0.001
Circulatory System	23	22.7	24	
Digestive System	11.1	10.9	11.7	
Musculoskeletal System & Connective Tissue	18.3	17.6	20.5	
Respiratory System	12.3	12.5	11.8	
Kidney & Urinary Tract	7.1	7.3	6.3	
Nervous System	6.9	6.8	7.4	

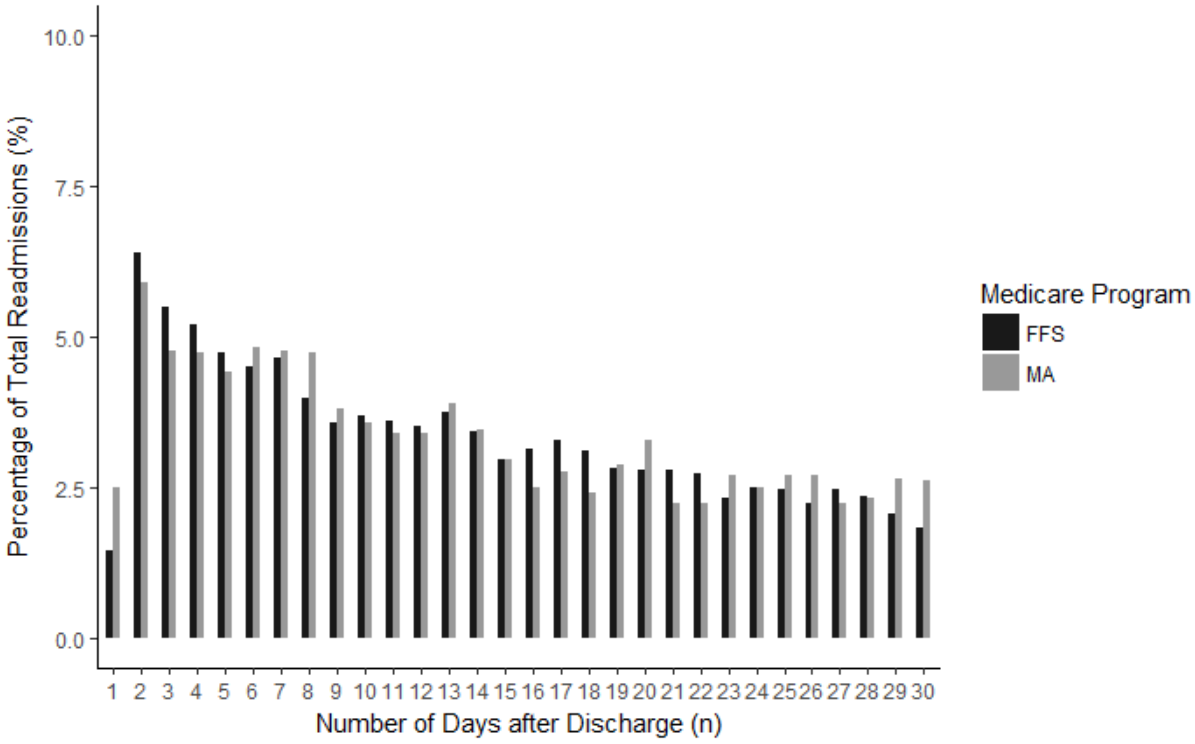
Infectious & Parasitic Diseases	6.8	6.9	6.6	
Factors Influencing Health Status	2.8	2.8	2.5	
Endocrine, Nutritional, & Metabolic	3	3.8	0.6	
Hepatobiliary System & Pancreas	2.1	2	2.3	
Skin, Subcutaneous Tissue & Breast	2.1	2.2	1.8	
Blood and Immunology	1.2	1.3	1.2	
Injuries, Poisonings, & Drug Toxicity	0.9	0.9	0.9	
Ear, Nose, Mouth, & Throat	0.7	0.7	0.6	
Female Reproductive System	0.3	0.3	0.3	
Male Reproductive System	0.3	0.3	0.3	
Eye	0.1	0.1	0.1	
Multiple Significant Trauma	0.1	0.1	0.1	
Others	0	0	0	
Unknown	0.8	0.8	0.9	

[a]Number of hospitalizations in 12 months prior to index hospitalization.

[b]Average days of hospitalization in 12 months prior to index hospitalization.

Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage; Avg=Average

Figure 1. Percentage of Total 30-Day Hospital Readmissions by Number of Days after Discharge by Medicare Program.



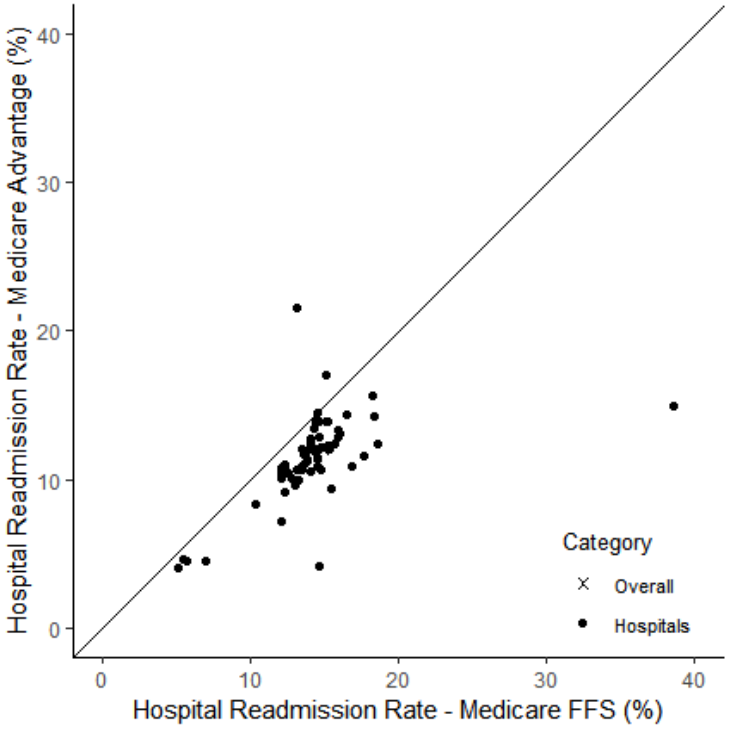
Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage

Table 2. Adjusted Association between Medicare Programs and 30-day Hospital Readmissions within the Same Hospital and across Hospitals, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (Reference group: Medicare Fee-for-Service; N=102,556).

	Conditional Logistic Regression Models		GEE Models	
	Odds Ratio (95% CI)	P-Value	Odds Ratio (95% CI)	P-Value
Unadjusted	0.84 (0.80-0.88)	<0.001	0.81 (0.77-0.86)	<0.001
Model 1[a]	0.83 (0.79-0.87)	<0.001	0.81 (0.77-0.86)	<0.001
Model 2[b]	0.92 (0.87-0.96)	<0.001	0.92 (0.86-0.98)	0.007
Model 3[d]	-	-	0.91 (0.86-0.97)	0.003

[a]Covariates include predisposing factors (age, sex, and patient residence in a rural area).
[b]Covariates include predisposing factors and need characteristics (principle diagnosis for index hospitalization based on major diagnostic categories, length of stay for index hospitalization, discharge location, hospice status, patient-level number of chronic conditions, number of hospitalizations and average days of hospitalization in 12 months prior to index hospitalization).
[c]Covariates include predisposing factors, need characteristics, and hospital characteristics (teaching status, size, urban/rural location, type, Medicaid inpatient, and staff level).
Note: GEE=Generalized Estimating Equations; CI=Confidence Interval

Figure 2. Hospital-level Risk Adjusted 30-day Hospital Readmission Rates by Medicare Program.

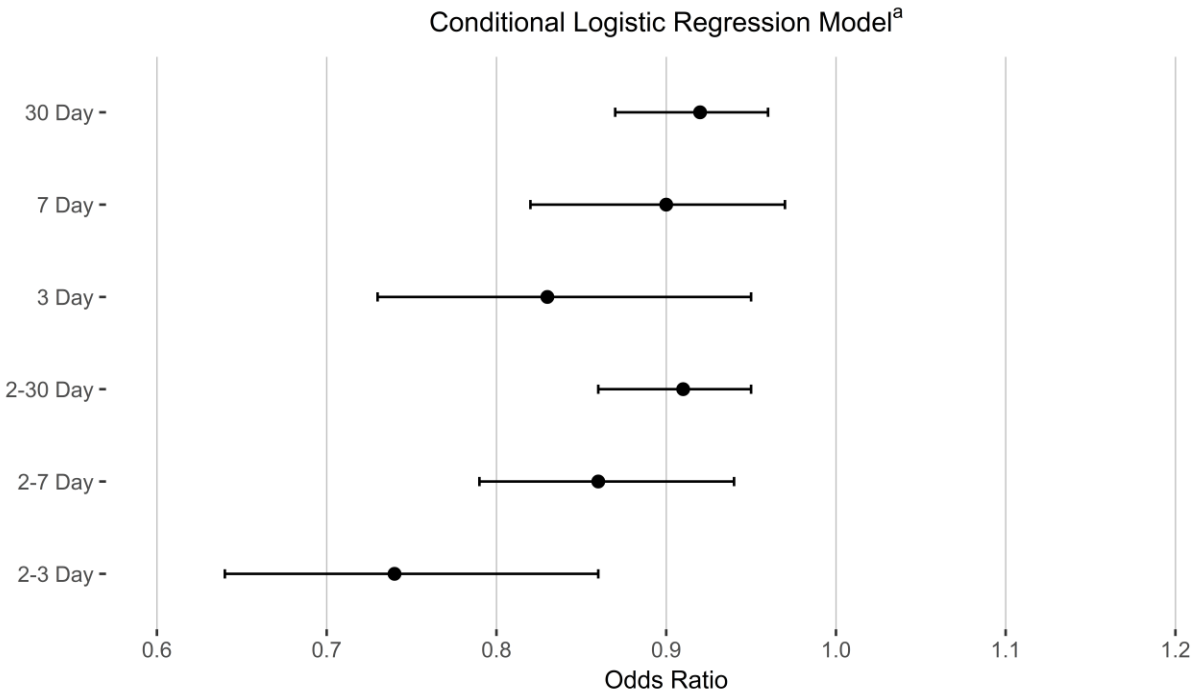


Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage

Appendix 1. Other Covariates' Categories.

Variable	**Categories**
Age	66-69; 70-74; 75-79; 80-84; 85-89; 90 or older
Gender	Male; Female
Residence	Urban; Rural
Principle diagnosis for index hospitalization based on major diagnostic categories	Circulatory System; Musculoskeletal System & Connective Tissue; Respiratory System; Digestive System; Kidney & Urinary Tract; Nervous System; Infectious & Parasitic Diseases; Factors Influencing Health Status; Endocrine, Nutritional, & Metabolic; Hepatobiliary System & Pancreas; Skin, Subcutaneous Tissue & Breast; Blood and Immunology; Injuries, Poisonings, & Drug Toxicity; Ear, Nose, Mouth, & Throat; Female Reproductive System; Male Reproductive System; Eye; Multiple Significant Trauma; Others (Burns, Myeloproliferative Diseases & Disorders, Human Immunodefiency Virus); Unknown
Discharge location	Home; Skilled Nursing Facility; Rehabilitation Facility
Length of stay during index hospitalization	<2; 2-3; 4-5; 6+
Number of hospitalizations in 12 months prior to index hospitalization	Continuous variable
Average days of hospitalization in 12 months prior to index hospitalization.	Continuous variable
Hospital teaching status	Teaching; Non-Teaching
Hospital bed size	Fewer than 100; 100-300; 300 or more
Hospital geographic location	Urban; Rural
Hospital tax status	For-profit; Non-for-profit
Hospital staffing level	Based on Hospital level Quartiles: Hospital staffing was measured as the ratio of registered nurse hours per adjusted patient day.
Hospital percentage of Medicaid inpatient days	Based on Hospital level Quartiles
Hospital average length of stay	Based on Hospital level Quartiles

Appendix 2. Adjusted Association between Medicare Programs and 30-day Hospital Readmissions within the Same Hospital with different Hospital Readmission Timeframe, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (N=102,556).



[a]Covariates include predisposing factors (age, sex, and patient residence in a rural area) and need characteristics (principle diagnosis for index hospitalization based on major diagnostic categories, length of stay for index hospitalization, discharge location, hospice status, patient-level number of chronic conditions, number of hospitalizations and average days of hospitalization in 12 months prior to index hospitalization).

Note: Medicare Program coded as dummy variable (reference group: Medicare Fee-for-Service)

Appendix 3. Adjusted Association between Medicare Programs and 30-day Hospital Readmissions within the Same Hospital and across Hospitals applying 30 minimum discharges for each Medicare programs per hospital, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (Reference group: Medicare Fee-for-Service; N=92,517).

	Conditional Logistic Regression Models		GEE Models	
	Odds Ratio (95% CI)	P-Value	Odds Ratio (95% CI)	P-Value
Unadjusted	0.84 (0.80- 0.88)	<0.001	0.81 (0.76-0.86)	<0.001
Model 1[a]	0.84 (0.80- 0.88)	<0.001	0.81 (0.76-0.86)	<0.001
Model 2[b]	0.92 (0.88- 0.97)	<0.001	0.92 (0.86-0.99)	0.019
Model 3[d]	-	-	0.92 (0.86-0.99)	0.012

[a]Covariates include predisposing factors (age, sex, and patient residence in a rural area).
[b]Covariates include predisposing factors and need characteristics (principle diagnosis for index hospitalization based on major diagnostic categories, length of stay for index hospitalization, discharge location, hospice status, patient-level number of chronic conditions, number of hospitalizations and average days of hospitalization in 12 months prior to index hospitalization).
[c]Covariates include predisposing factors, need characteristics, and hospital characteristics (teaching status, size, urban/rural location, type, Medicaid inpatient, and staff level).
Note: GEE=Generalized Estimating Equations; CI=Confidence Interval

Appendix 4. Adjusted Association between Medicare Programs and 30-day Hospital Readmissions within the Same Hospital with Different Adjustment for Need Characteristics, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (N=102,556).

	Conditional Logistic Regression Models	
	Odds Ratio (95% CI)	P-Value
Model 1[a]	0.91 (0.87-0.95)	<0.001
Model 2[b]	0.93 (0.89-0.98)	<0.001
Model 3[c]	0.84 (0.80-0.88)	<0.001
Model 4[d]	0.84 (0.80-0.88)	<0.001
Model 5[e]	0.83 (0.79-0.87)	<0.001

[a]Covariates include predisposing factors (age, sex, and patient residence in a rural area) and need characteristics (principle diagnosis for index hospitalization based on major diagnostic categories, length of stay for index hospitalization, discharge location, hospice status, patient-level number of chronic conditions, number of hospitalizations and average days of hospitalization in 12 months prior to index hospitalization).

[b]Covariates include predisposing factors and patient's number of chronic conditions

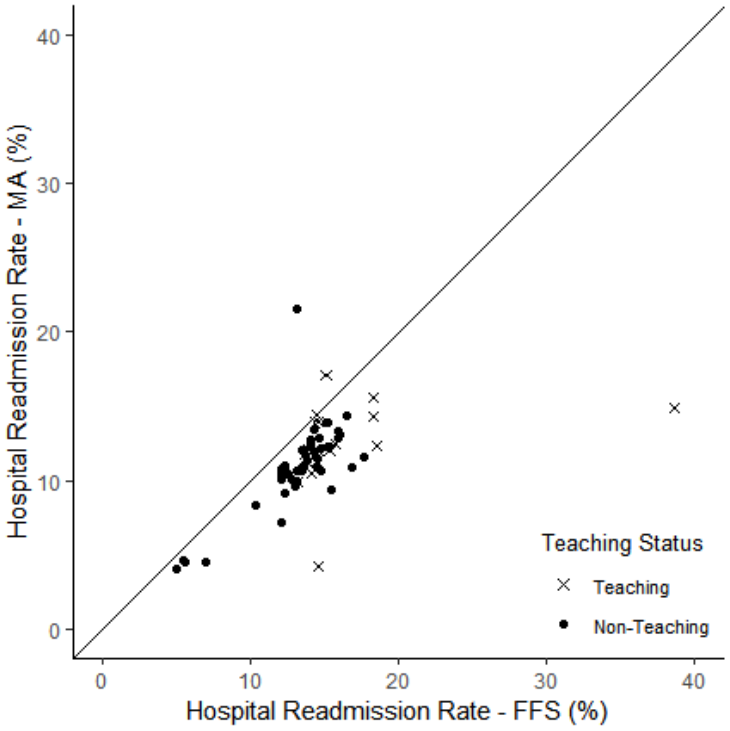
[c]Covariates include predisposing factors and length of stay for index hospitalization

[d]Covariates include predisposing factors and principle diagnosis for index hospitalization based on major diagnostic categories

[d]Covariates include predisposing factors and number of hospitalizations in 12 months prior to index hospitalization

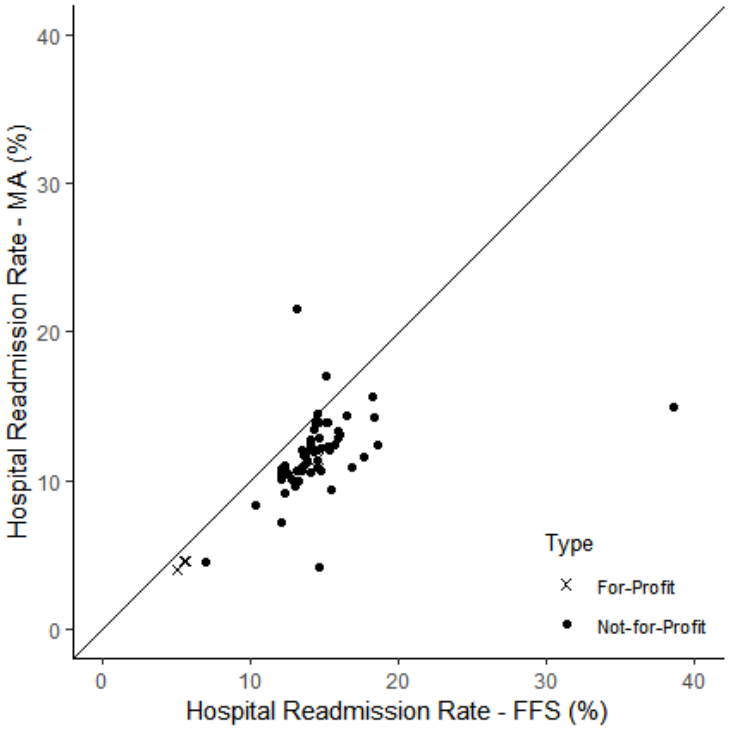
Note: CI=Confidence Interval

Appendix 5-a. Hospital-level Risk Adjusted 30-day Hospital Readmission Rate by Medicare Program and Hospital Teaching Status.



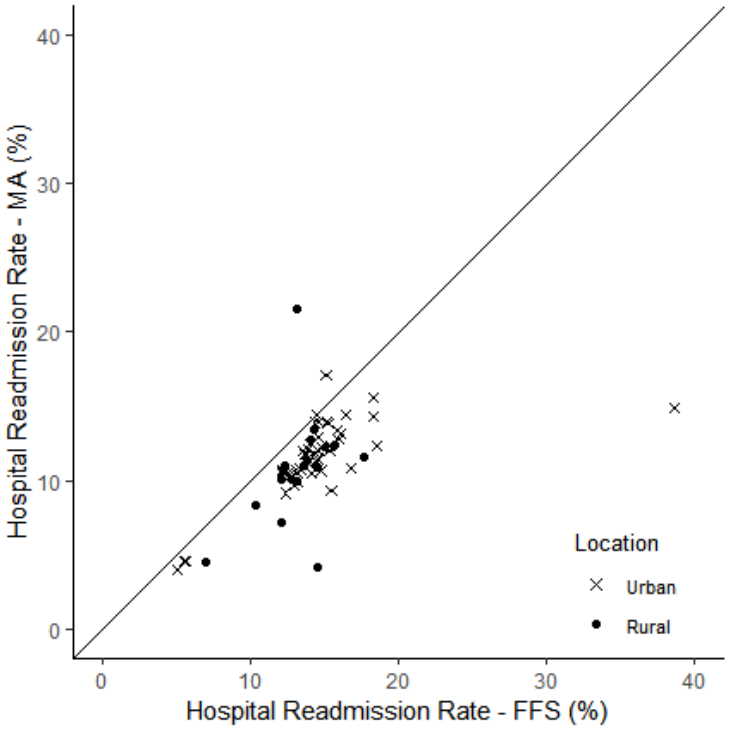
Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage

Appendix 5-b. Hospital-level Risk Adjusted 30-day Hospital Readmission Rate by Medicare Program and Hospital Type.



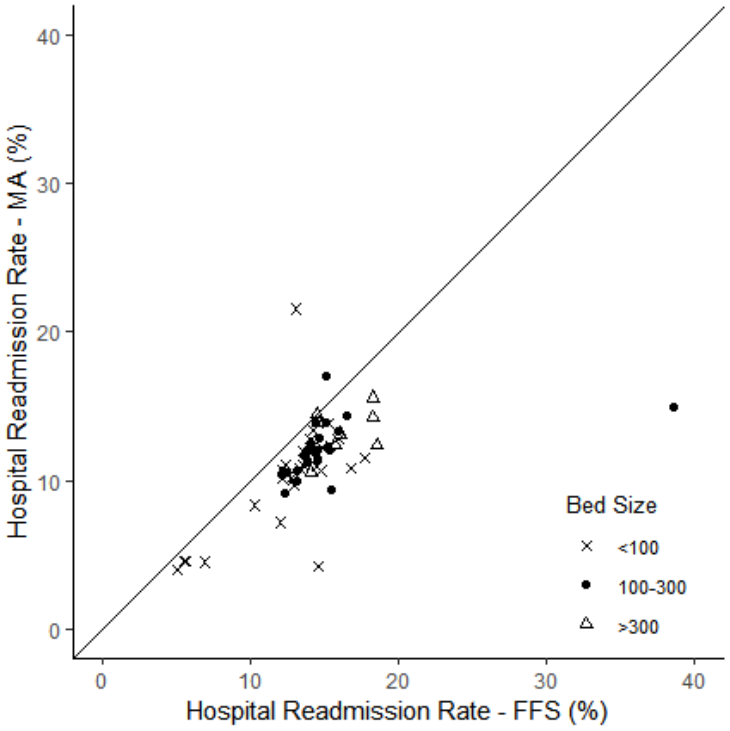
Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage

Appendix 5-c. Hospital-level Risk Adjusted 30-day Hospital Readmission Rate by Medicare Program and Hospital Geographic Location.



Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage

Appendix 5-d. Hospital-level Risk Adjusted 30-day Hospital Readmission Rate by Medicare Program and Hospital Bed Size.



Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage

Chapter 3

Differences in All-Cause 30-Day Readmission Rates between Medicare Fee-for-Service and Medicare Advantage: The Role of Chronic Conditions

ABSTRACT

Background. It is known that beneficiaries in Medicare Advantage receive higher quality of care than those in Medicare fee-for-service which is an important component to care patients, especially with higher comorbidity. While we know that the 30-day readmission rate in MA is lower than FFS, we have no information on how the readmission rate difference between FFS and MA varies by patients' number of chronic conditions.

Objective. To determine whether the patient-level number of chronic conditions moderates the association between Medicare programs and 30-day all-cause hospital readmissions.

Research Design. Using the Wisconsin Health Information Organization all payer claims database from 2012 to 2014, we used multivariate models to estimate the probabilities of readmission by Medicare program and number of chronic conditions.

Results. The overall predicted probability of readmission in Medicare fee-for-service (14.9 percent) was 24 percent higher than that in Medicare Advantage (12 percent). The predicted probabilities of readmission increase as the number of chronic conditions increases in both Medicare programs. However, we were not able to find difference in the risk of readmission between Medicare FFS and MA among patients with 6 or more chronic conditions.

Conclusion. Our findings suggest that comparing the overall readmission rates provides limited information for understanding differences between FFS and MA. Stratifying information by

patients' health status in Medicare FFS and MA comparison could produce helpful information to identify target groups and further opportunities to reduce readmissions in Medicare.

INTRODUCTION

Reducing hospital readmissions in Medicare is a national priority for improving health outcomes and lowering health care spending.[1] Despite recent efforts to reduce readmissions in Medicare, a significant proportion of 30-day readmissions in Medicare is still considered avoidable.[2] One possible way to produce helpful information to reduce hospital readmissions in Medicare is comparing Medicare fee-for-service (FFS) and Medicare Advantage (MA), the two main mechanisms to pay for covered services received by Medicare beneficiaries, within the context of readmissions. Comparison between Medicare FFS and MA could develop benchmarks for readmissions and related factors, and identify factors and patient groups for targeted improvement efforts. Previous studies have found that beneficiaries in MA are younger, healthier, and receive higher quality of care than those in Medicare FFS.[3–9] While the overall 30-day readmission rates in Medicare FFS are nearly 15-30 percent higher than in MA,[10,11] we have less detailed information to understand the readmission rate difference by Medicare program. In addition, even though patients with greater number of chronic conditions require higher quality of care including coordinated care, producing similar health outcomes for these patients gets more difficult compared to those with lower number of chronic conditions. Considering these differences by number of chronic conditions, clarifying whether the association between Medicare programs and 30-day readmissions varies by patient's number of chronic conditions could provide deeper insight into the specific pattern within the overall readmission rate difference between Medicare FFS and MA. Such clarification is also important to identify potential subgroups who may need additional attention and targeted interventions to efficiently prevent readmissions. However, previous studies comparing the readmission rate between Medicare FFS and MA focused on the overall 30-day readmissions.

Previous studies have found that a greater number of chronic conditions is associated with higher risk of readmission[12–14] as well as low quality of life,[15] functional limitations,[16] and mortality.[17–19] Also, while older adults with 6 or more chronic conditions account for 14 percent of beneficiaries in FFS, they account for nearly half of the readmissions.[14] Therefore, differences in the health represented by the number of chronic conditions is one factor which could affect the difference in readmission rates between Medicare FFS and MA. Consistent with this expectation, previous studies have shown that older adults in Medicare FFS are more likely to report more chronic conditions than those in MA,[20] and that adjusting for health status including comorbidity narrowed the 30-day readmission rate difference between Medicare FFS and MA.[10,11]

However, the number of chronic conditions reflects not only the severity of illness but also the complexity of care. The care for patients with multiple chronic conditions involves multiple providers with complex care plans which requires high quality of care, including care coordination, especially for sicker patients with greater numbers of chronic conditions.[7–9] However, patients with greater numbers of chronic conditions are known to be more vulnerable to fragmented care and low quality of transitional care which increases the risk of readmission.[13,21] It is known that MA beneficiaries receive higher quality of care and are expected to receive better coordinated care than Medicare FFS beneficiaries.[3–6] However, we have less information on whether the readmission rate difference between Medicare FFS and MA is consistent across patients with different numbers of chronic conditions, especially those with greater number of chronic conditions. This information is important not only to produce evidence about whether Medicare programs are managing patients differently or not by different numbers of chronic conditions, but also to identify potential target groups and benchmarks to improve the care and reduce readmissions. Considering the greater importance of care quality

among patients with larger numbers of chronic conditions, there is a possibility that readmission rate differences between Medicare FFS and MA could increase with a greater number of chronic conditions. Conversely, due to the complexity of care for patients with greater numbers of chronic conditions, providing care that could produce similar results could be more challenging as the number of chronic conditions increases, which in turn could mitigate the difference in readmission rates between Medicare FFS and MA in unhealthy patients. Therefore, while the readmission rate difference between Medicare FFS and MA is not expected to be same across patients with different numbers of chronic conditions, our current understanding on the association between Medicare programs and readmissions focuses on the overall readmission rate.

Therefore, in this study we examine whether the patients-level number of chronic conditions moderates the association between Medicare programs and 30-day readmissions. We predict the probabilities of readmission by Medicare program and number of chronic conditions to assess whether the difference in readmission rates between Medicare FFS and MA varies by number of chronic conditions. We hypothesize that differences in readmission rates by Medicare program will be greater in beneficiaries with 2 or more chronic conditions compared to those with 0 or 1 chronic conditions. However, we expect that the difference will be attenuated as the number of chronic conditions increases.

METHODS

Data Source

We used data from the Wisconsin Health Information Organization (WHIO) all-payer claims data (APCD) version 13 of the data mart (DMV13) which covers October 2012 to

December 2014. WHIO is a voluntary APCD in Wisconsin which collects large sets of administrative claims and eligibility data from WHIO members twice annually. The WHIO APCD data includes medical, dental, and pharmaceutical claims data with patient demographics from various payers including private insurance, Medicare, and Medicaid.

We also used and merged the 2013 American Hospital Association's (AHA) Annual Survey data to obtain hospital characteristics by using Medicare provider number. The AHA Annual Survey is administered annually by the AHA which compiles responses from 6200 hospitals nationwide and contains thousands of fields of information categorizing an institution's organizational structure, facility and service lines, inpatient and outpatient utilization, operation expenses, and staffing.

Sample

In this study, we focused our analysis on patients who were hospitalized in an acute care hospital in Wisconsin during October 1, 2013 to September 30, 2014. We included patients over the age of 66 at the time of index hospitalization and alive upon discharge. Patients continuously enrolled in the same Medicare program for the 12 months prior to the index admission, and continuously enrolled 30 days after discharge were included. We excluded patients with incomplete data due to receipt of railroad benefits, and readmissions that are considered planned readmissions.[22] Other exclusion criteria were patients transferred to another acute care hospital upon discharge or discharged against medical advice.[22] Our study sample included 102,556 discharges from 66 hospitals.

Study Variables

Dependent Variable

Our outcome variable of interest was an unplanned 30-day all-cause readmission. We used the Centers for Medicare and Medicaid Services (CMS) definition of readmissions developed by the Yale School of Medicine Center for Outcomes Research & Evaluation to measure readmission.[22] Medicare beneficiaries age 66 or older who were hospitalized at a short-stay acute-care hospital and experienced an unplanned readmission for any cause to an acute care hospital within 30 days of discharge were defined as readmitted. The first readmission is considered as a readmission if there is more than one unplanned admission within 30 days of discharge from the index hospitalization.

Independent Variables

Independent variables consisted of type of Medicare program and the number of chronic conditions. We categorized individuals to Medicare FFS and MA based on being continuously enrolled in the same Medicare program for 12 months prior to the index hospitalization and 30 days after discharge from the index hospitalization

We used the Elixhauser Comorbidity Method and dementia to define the number of chronic conditions using 12 months of claims data before index hospitalization. The Elixhauser Comorbidity Method is a commonly used algorithm for counting a patient's number of comorbidities based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data.[23] The Elixhauser Comorbidity Method was developed to predict in-hospital mortality using large administrative data sets, but has been applied to other studies of readmission. We defined dementia based on the ICD codes that were used in previous studies to identify dementia in Medicare claims.[24,25] We categorized chronic conditions to 0-1, 2-3, 4-5, 6-7,

8-9, and 10+ to conduct this study as the association between number of chronic conditions and readmissions was not expected to be linear.[14,26]

Covariates

Several individual- and hospital-level variables were included in the analyses as control variables. We used the Health Behavior Model to select individual characteristics including age, sex, and patient's residence in a rural area as predisposing factors.[27] We also included principle diagnosis for index hospitalization defined by major diagnostic categories, discharge location, length of stay during the initial hospitalization, number of hospitalizations and average days hospitalized per hospitalization in 12 months prior to index hospitalization as need characteristics. Hospital teaching status, hospital bed size, hospital geographic location, type of hospital, and hospital staffing level were included as hospital-level variables. We also included hospital average length of stay and hospital percentage of Medicaid inpatient days to measure patient composition in the hospital. A list of covariate categories is provided in Appendix Table 1.

Statistical Analyses

We first examined the characteristics of hospital discharges by Medicare program. Next, we used a generalized estimating equation (GEE) approach with independent working correlation within hospitals to fit and test multivariate logistic regression models to examine whether the association between Medicare programs and 30-day readmissions varies by a patient's baseline number of chronic conditions adjusting for individual- and hospital-level factors. To capture whether the number of chronic conditions moderates the association between Medicare programs and readmission, an interaction term between Medicare program and number of chronic conditions was included. We calculated the predicted probabilities of 30-day readmission by Medicare program and number of chronic conditions based on the regression

model to capture the full marginal effect including the interaction term.[29] To estimate the relative risks of readmission between Medicare FFS and MA by number of chronic conditions, we divided the mean predicted probabilities of readmission in Medicare FFS by that of MA by number of chronic conditions; confidence intervals were calculated by using the cluster bootstrapping method. Analyses were conducted in R Studio 3.3.2.[i]

We also conducted several sensitivity analyses. We used different category definitions for the number of chronic conditions. Also, instead of using 12 months of administrative data before hospitalization to count the number of chronic conditions, we conducted the analysis using the whole administrative data. Moreover, as older age is positively associated with greater number of chronic conditions and therefore partially explains the complexity of care due to number of chronic conditions, we ran the analysis without adjusting for age. Lastly, as there could be a difference in the number of chronic conditions between Medicare FFS and MA within those with 10 or more chronic conditions, we conducted the analysis without patients with 12 or more chronic conditions.

RESULTS

Table 1 describes the characteristics of the 102,556 patient discharges used in the analysis. Approximately, three out of four discharges belong to Medicare FFS. Overall, Medicare FFS patients were more likely to be older (85 or older – FFS: 26.8%; MA: 21.7%), female (FFS: 58.4%; MA:53.8%), and have more chronic conditions (6 or more – FFS: 31.2%; MA: 20.9%). Medicare FFS patients were more likely to experience not only longer length of stay during their

[i] We additionally applied the inverse propensity score as a weight in the main analysis to adjust for selection bias. There was no difference in the study results between analysis with and without propensity score method.

index hospitalization (4 or longer – FFS: 47.1%; MA: 42.7%), but also a greater number of hospitalizations (Mean (Standard Deviation (SD)) - FFS: 0.90 (1.41); MA: 0.76 (1.24)) and average days of hospitalization (Mean (SD) – FFS: 2.36 (4.12); MA: 2.20 (5.12)), both during a year before their index hospitalization. Patients in MA were more likely to be discharged to home compared to those in Medicare FFS (FFS: 69.8%; MA: 76.1%), while patients in Medicare FFS were more likely to be discharged to skill-nursing home than those in MA (FFS: 27.9%; MA: 19.6%).

Table 2 reports the odds ratio (OR) of hospital readmissions using multivariate logistic regression models. In Model 1, we find that the odds of hospital readmissions in MA were 0.91 times lower than Medicare FFS (OR,0.91; 95% Confidence Interval (CI), 0.86-0.97; P<0.001). The odds of 30-day hospital readmission were higher among those with higher number of chronic conditions. While the odds of hospital readmission among patients with 2-3 chronic conditions were 1.35 times higher than for those with 0-1 chronic conditions (OR, 1.35; 95% CI, 1.25-1.45; P<0.001), the odds of hospital readmission among patients with 10 or more chronic conditions were 2.32 times higher compared to patients with 2-3 chronic conditions (OR, 2.32; 95% CI, 1.99-2.69; P<0.001). In Model 2, which includes an interaction term between Medicare programs and number of chronic conditions, we find a significant difference in the odds of readmission by number of chronic conditions for patients with 4-5 chronic conditions (OR, 1.18; 95% CI, 1.02-1.36; P=0.025) compared to patients with 0-1 chronic conditions.

Table 3 shows the results from formal tests of interaction between Medicare programs and different definitions of the number of chronic conditions. The results show that the interaction terms based on odds ratios were not statistically significant based on an alpha level of 0.05. However, defining the number of chronic conditions as a categorical (P=0.058) or

continuous variable (P=0.058) results in p-values only slightly greater than .05, providing suggestive evidence for interactions between Medicare programs and number of chronic conditions on readmission odds.

Figure 1 shows the predicted probability of hospital readmission by Medicare program and patients-level number of chronic conditions. We find that the predicted probabilities of hospital readmission increase as the number of chronic conditions increase both in Medicare FFS and MA. The overall predicted probability of readmission in Medicare FFS (14.9 percent) was higher than that in MA (12.0 percent). When stratifying by number of chronic conditions, the study results show that greater number of chronic conditions is consistently associated with higher probabilities of readmission in both Medicare programs.

Figure 2 displays the relative risks of hospital readmission between Medicare FFS and MA by number of chronic conditions. Overall, the predicted probability of readmission in FFS is nearly 1.24 times higher than MA. Relative risks of readmission between Medicare FFS and MA varies from 1.01 to 1.23 times across number of chronic conditions, except the 4-5 chronic conditions group. Risks of readmission in Medicare FFS were 18 percent and 23 percent higher than those in MA among patients with 0-1 and 2-3 chronic conditions, respectively (chronic condition: 0-1, relative risk (RR):1.18; chronic condition: 2-3, RR:1.23). Among patients with 4-5 chronic conditions, the relative risk was 0.97 which shows that the predicted probability of readmission in Medicare FFS is lower than MA. We find there is no significant difference in the risk of readmission among those with 6-7 and 8-9 chronic conditions (chronic condition: 6-7, RR:1.01; chronic condition: 8-9, RR:1.01). While the risk of readmission in Medicare FFS was 21 percent higher than that in MA among patients with 10 or more chronic conditions (chronic condition: 10 or more, RR:1.21), there was no difference in the risk of readmission between

Medicare FFS and MA when we excluded patients with 12 or more chronic conditions (Appendix Figure 4, chronic condition: 10-11, RR:1.00)

DISCUSSION

In this study, we find that patients in Medicare FFS were more likely to be older and have more chronic conditions than MA patients. Also, Medicare FFS patients had longer hospitalization stays and more hospitalizations before the index hospitalization than those in MA. Our study results also show that 1) the overall 30-day readmission risk in Medicare FFS is higher than in MA[10,11,30] and 2) higher number of chronic conditions are associated with higher risks of readmission.[13,14,31] Formal tests of interaction between Medicare programs and the number of chronic conditions based on odds ratios, while not statistically significant, provide some suggestive evidence of interaction between Medicare program and the number of chronic conditions on readmissions. Also, the main analyses based on relative risk show that while the overall readmission risk in Medicare FFS is higher than in MA, the strength of associations between Medicare programs and hospital readmissions are not consistent across chronic conditions categories.

Our study results fill a gap in the literature by identifying the direction and strength of associations between Medicare programs and 30-day hospital readmissions, showing how these associations vary by patient's number of chronic conditions. Other studies also have shown that the association between individual characteristics and adverse health outcomes varies by the number of chronic conditions.[32,33] For example, Tonelli et al. have shown that the difference between patients with and without dementia in risk of adverse health outcomes was lower with a greater number of chronic conditions.[33] In our study, the risk of 30-day readmission in Medicare

FFS was higher than that in MA among patients with 0-1 and 2-3 chronic conditions with similar strength of association. However, it was hard to find a significant difference in the risk of readmission between Medicare FFS and MA among patients with 6 or more chronic conditions, and the risk of readmission was higher in MA than in Medicare FFS among patients with 4-5 chronic conditions. Our study results suggest that comparing the overall readmission risks provides limited information for understanding differences between Medicare FFS and MA, and the difference in risk of readmission between Medicare FFS and MA is driven by patients with lower number of chronic conditions.

One possible explanation for greater relative readmission risk difference by Medicare program among those with lower number of chronic conditions is that, assuming MA does provide better care than Medicare FFS,[3,4,34] MA may not be providing better care for patients with greater comorbidity than they do for those with lower comorbidity. Considering the increasing complexity of care and severity of illness according to greater number of chronic conditions, it could be more difficult to produce the same difference in the quality of care and risk of readmission between MA and Medicare FFS among patients with greater number of chronic conditions than those with lower number of chronic conditions.

MA plans are expected to provide better care coordination with approaches such as gatekeeping systems, robust information system, and network contracting, which could enhance the transitional care than Medicare FFS (G. Anderson, 2009; Better Medicare Alliance, 2017; Landon et al., 2012; Li et al., 2018). However, we have no clear evidence that directly supports MA beneficiaries receive better coordinated care than those in Medicare FFS. This study found that most of the difference in risk of readmission between Medicare FFS and MA is driven by patients with lower number of chronic conditions and no significant difference among patients

with greater number of chronic conditions. Considering care coordination is an important component for successful care, especially for patients with multiple chronic conditions,[7–9] these findings raise the possibility that MA beneficiaries with greater number of chronic conditions are not receiving better coordinated care than those in Medicare FFS.

This study suggest that stratified information related to readmissions could be helpful in target services. The majority of current policies and information related to readmissions have been focused on overall and condition-specific readmission rate including acute myocardial infarction, heart failure, and pneumonia. Information related to readmissions stratified by patients' number of chronic conditions could delivery useful evidence to policy-makers to modify and develop programs that could achieve further quality of care improvement and readmissions reduction in Medicare. For example, several interventions to improve transitional care and care coordination, and models including accountable care organizations are known to be effective in reducing readmissions.[36–38] However, while past studies have focused on specific health conditions such as acute myocardial infarction and heart failure,[39,40] we have less information on how the effect of these interventions varies by patient's number of chronic conditions which represents the severity of illness and complexity of care. Producing stratified information by patient's number of chronic conditions could help us identify opportunities to facilitate hospital readmission reduction based on how to apply and develop interventions to improve care and whether we need further attention according to some targeted group.

This analysis contains following limitations. First, comorbidity measures are constructed by using one year of administrative data. Therefore, for individuals having a disease but lacking any health service records containing the diagnosis of that disease during the timeframe, this would not be captured in the comorbidity measure for that disease. However, our sensitivity

analysis, which utilized the entire administrative data, shows qualitatively similar results to the main analysis. Also, this data have no information for race/ethnicity. In addition, this study is based on Wisconsin data which could limit generalizability to other states. While Wisconsin has unique characteristics such as a relatively higher proportion of provider-owned health plans, however, Medicare is a federal program and the majority of MA plans operate in multiple states.[41] Thus, this study results provide applicable information to Medicare and policy makers as well as MA health plans. The third limitation is that these data do not include mortality information, which is more associated with great number of chronic conditions and considered as a potential alternative outcome of readmission, and therefore could confound the associations of the number of chronic conditions on Medicare programs and readmissions. Lastly, this study may not reflect the full effect of recent initiatives that CMS undertaken such as the Medicare Hospital Readmission Reduction Program because of the data including the early years of these initiatives.

In conclusion, our study finds that risk of readmission differences between Medicare FFS and MA vary by the patients' number of chronic conditions and we could only find differences among patients with lower number of chronic conditions. Our findings suggest that comparing the overall readmission rates provides limited information for understanding differences between FFS and MA. Stratifying information by patients' health status in Medicare FFS and MA comparison could produce helpful information to identify target groups and further opportunities to reduce readmissions in Medicare. Furthermore, stratified information by patients' number of chronic conditions status on readmission risk factors and interventions to reduce readmissions could be beneficial to efficiently reduce readmissions and promote interventions.

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Table 1. Characteristics of Discharges by Medicare Program, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (N=102,556).

	Overall	FFS	MA	p-value
N	102,556	77,237	25,319	
Age (%)				<0.001
66-69	16.4	16.3	16.8	
70-74	19.6	19	21.3	
75-79	19.6	19.2	21	
80-84	18.8	18.6	19.2	
85-89	13.2	13.4	12.4	
90+	12.4	13.4	9.3	
Gender = Female (%)	57.3	58.4	53.8	<0.001
Residence = Rural (%)	13	12.5	14.3	<0.001
Hospice = Hospice (%)	2.6	3.4	0	<0.001
Length of Stay (%)				<0.001
<2	11.1	10.3	13.3	
2-3	42.9	42.6	43.9	
4-5	23.2	23.7	21.5	
6+	22.9	23.4	21.2	
Number of Hospitalizations[a] (mean (sd))	0.86 (1.37)	0.90 (1.41)	0.76 (1.24)	<0.001
Avg Days of Hospitalizations[b] (mean (sd))	2.32 (4.39)	2.36 (4.12)	2.20 (5.12)	<0.001
Number of Chronic Conditions (%)				<0.001
0-1	18.5	16.8	23.4	
2-3	29.2	27.9	32.9	
4-5	23.7	24	22.8	
6-7	15.8	16.8	12.8	
8-9	8.4	9.3	5.6	
10+	4.5	5.1	2.5	
Principle Diagnosis for Index Hospitalization (%)				<0.001
Circulatory System	23	22.7	24	
Musculoskeletal System & Connective Tissue	18.3	17.6	20.5	
Respiratory System	12.3	12.5	11.8	
Digestive System	11.1	10.9	11.7	
Kidney & Urinary Tract	7.1	7.3	6.3	
Nervous System	6.9	6.8	7.4	
Infectious & Parasitic Diseases	6.8	6.9	6.6	
Factors Influencing Health Status	2.8	2.8	2.5	
Endocrine, Nutritional, & Metabolic	3	3.8	0.6	
Hepatobiliary System & Pancreas	2.1	2	2.3	

Skin, Subcutaneous Tissue & Breast	2.1	2.2	1.8	
Blood and Immunology	1.2	1.3	1.2	
Injuries, Poisonings, & Drug Toxicity	0.9	0.9	0.9	
Ear, Nose, Mouth, & Throat	0.7	0.7	0.6	
Female Reproductive System	0.3	0.3	0.3	
Male Reproductive System	0.3	0.3	0.3	
Eye	0.1	0.1	0.1	
Multiple Significant Trauma	0.1	0.1	0.1	
Others	0	0	0	
Unknown	0.8	0.8	0.9	
Discharge Location/Service (%)				<0.001
Home	71.4	69.8	76.1	
SNF	25.9	27.9	19.6	
Rehab	2.8	2.3	4.3	
Hospital Teaching Status = Teaching (%)	54.4	54.8	53.3	<0.001
Hospital Bed Size (%)				<0.001
Fewer than 100	21.5	21.5	21.4	
100-300	47.9	45.2	55.9	
300 or more	30.6	33.2	22.7	
Hospital Location = Rural (%)	14.1	13.7	15.2	<0.001
Hospital Tax Status = For-profit (%)	0.9	0.9	0.9	0.887
Hospital Average Length of Stay (%)				<0.001
Q1	10.7	10.6	11.1	
Q2	17.2	15.3	22.9	
Q3	25.9	24	31.5	
Q4	46.3	50.1	34.4	
Hospital Percentage of Medicaid Inpatient Days (%)				<0.001
Q1	20.9	20.3	22.8	
Q2	20.2	19	24	
Q3	31.6	36.2	17.3	
Q4	27.3	24.5	35.9	
Hospital Staff Level (%)				<0.001
Q1	16.2	14.2	22.3	
Q2	20.2	18	26.8	
Q3	34.6	37	27.2	
Q4	29.1	30.8	23.8	

[a]Number of hospitalizations in 12 months prior to index hospitalization.

[b]Average days of hospitalization in 12 months prior to index hospitalization.

Note: Avg=Average; FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Table 2. Adjusted Associations between Medicare Programs and 30-day Hospital Readmissions by Number of Chronic Conditions, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (N=102,556).

	Model 1[a]		Model 2[b]	
	OR (95% CI)	P-Value	OR (95% CI)	P-Value
Medicare Program				
Medicare Fee-for-Service	Ref		Ref	
Medicare Advantage	0.91 (0.86-0.97)	0.003	0.86 (0.74-0.98)	0.015
Chronic Conditions				
0-1	Ref		Ref	
2-3	1.35 (1.25-1.45)	<0.001		<0.001
4-5	1.70 (1.57-1.84)	<0.001	1.22 (1.14-1.30)	<0.001
6-7	1.97 (1.81-2.14)	<0.001	1.45 (1.33-1.57)	<0.001
8-9	2.13 (1.91-2.38)	<0.001	1.57 (1.42-1.74)	<0.001
10+	2.32 (1.99-2.69)	<0.001	1.73 (1.51-1.97)	<0.001
Medicare Program * Chronic Conditions				
Medicare Advantage * 0-1	-	-	Ref	
Medicare Advantage * 2-3	-	-	0.95 (0.81-1.12)	0.548
Medicare Advantage * 4-5	-	-	1.18 (1.02-1.36)	0.025
Medicare Advantage * 6-7	-	-	1.09 (0.95-1.26)	0.232
Medicare Advantage * 8-9	-	-	1.10 (0.89-1.37)	0.378
Medicare Advantage * 10+	-	-	1.03 (0.78-1.36)	0.825

[a]Covariates include predisposing factors (age, sex, and patient residence in a rural area), need characteristics (principle diagnosis for index hospitalization based on major diagnostic categories, length of stay for index hospitalization, discharge location, hospice status, patient-level number of chronic conditions, number of hospitalizations and average days of hospitalization in 12 months prior to index hospitalization), and hospital characteristics (teaching status, size, urban/rural location, type, Medicaid inpatient, and staff level).

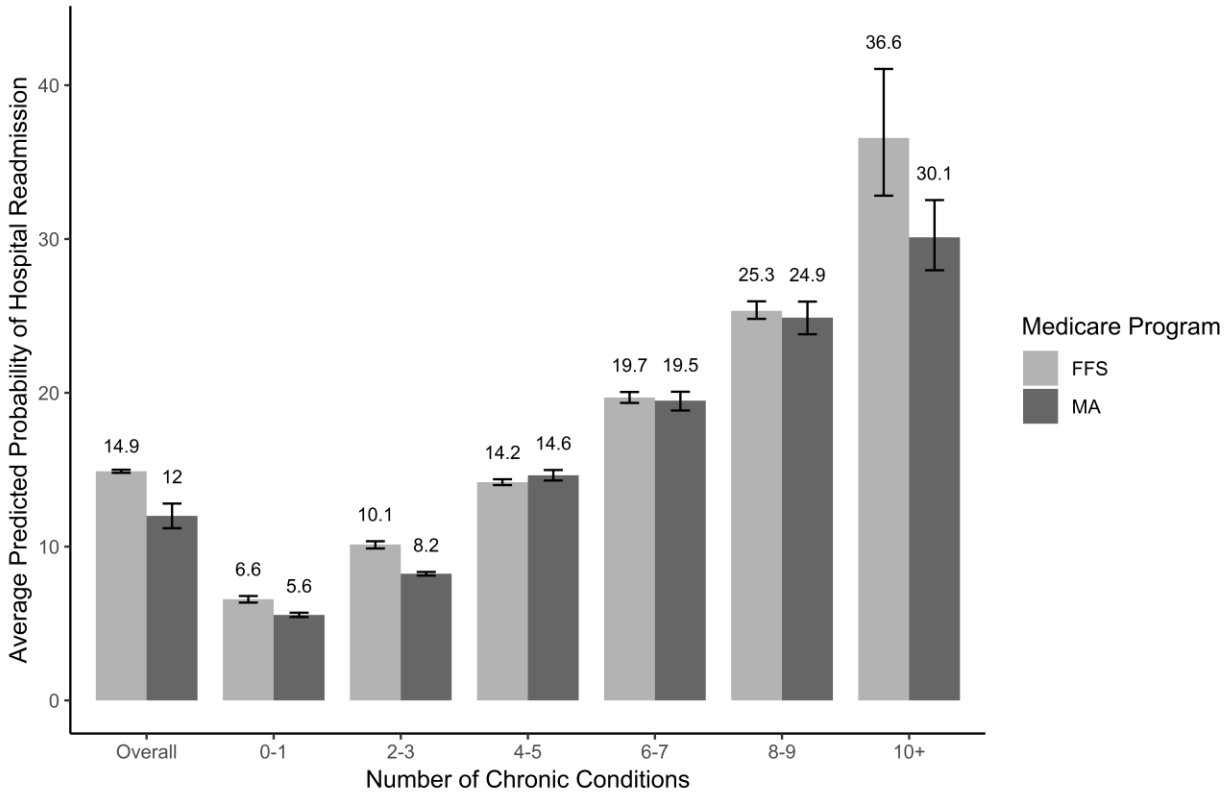
[b]Covariates include predisposing factors, need characteristics, hospital characteristics, and interaction term between number of chronic conditions and Medicare programs.

Note: OR=Odds Ratio; CI=Confidence Interval.

Table 3. Test for Interaction Term between Medicare Programs and Number of Chronic Conditions by Different Definition of Number of Chronic Conditions.

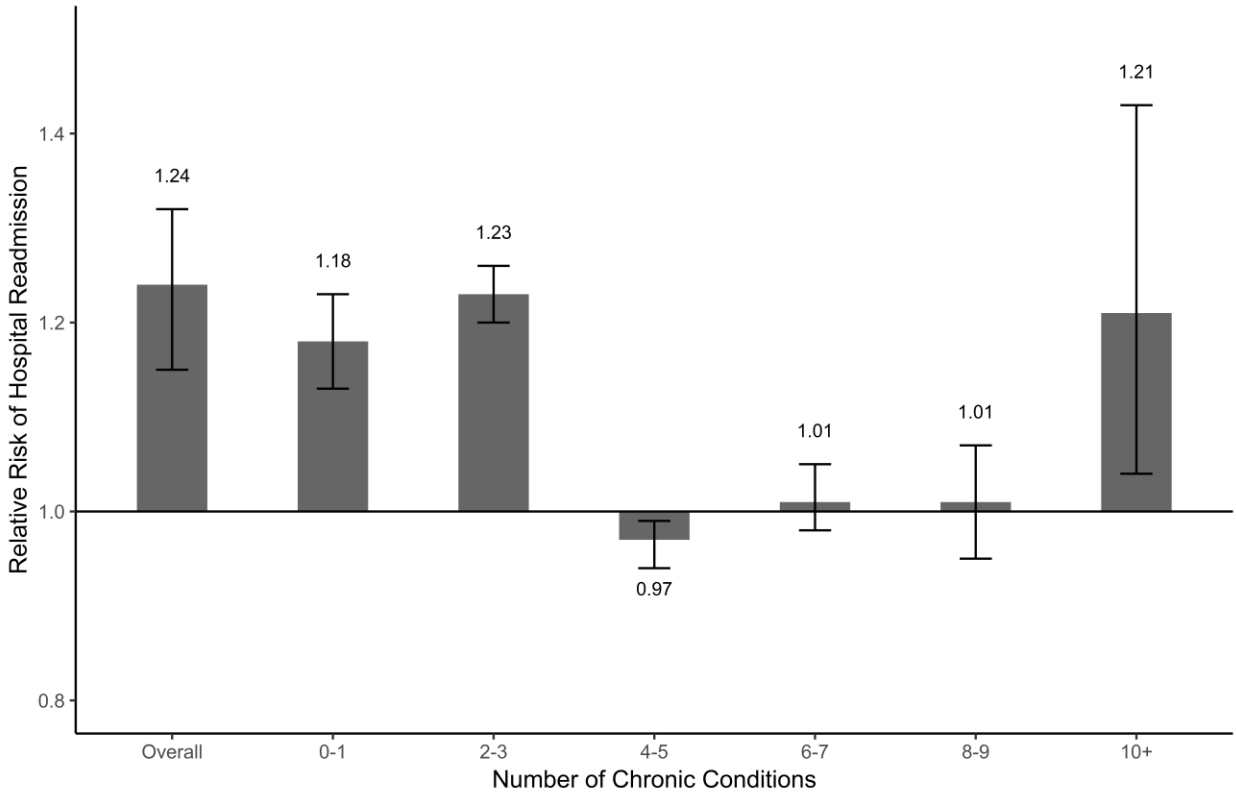
Chronic Conditions	P-Value
Continuous Variable	0.058
0-1, 2-3, 4-5, 6-7, 8-9, 10+	0.058
0, 1+	0.680
0-1, 2+	0.641

Figure 1. Predicted Probabilities of 30-Day Hospital Readmission by Medicare Program and Number of Chronic Conditions.



Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Figure 2. Relative Risks of 30-Day Hospital Readmission between Medicare Fee-for-Service and Medicare Advantage by Number of Chronic Conditions.



Note: Relative risk was calculated based on probability of readmission in Medicare Fee-for-Service as numerator and risk of readmission in Medicare Advantage as denominator.

Appendix Table 1. Other Covariates' Categories.

Variable	**Categories**
Age	66-69; 70-74; 75-79; 80-84; 85-89; 90 or older
Gender	Male; Female
Residence	Urban; Rural
Principle Diagnosis for Index Hospitalization based on Major Diagnostic Categories	Circulatory System; Musculoskeletal System & Connective Tissue Respiratory System Digestive System Kidney & Urinary Tract Nervous System Infectious & Parasitic Diseases Factors Influencing Health Status Endocrine, Nutritional, & Metabolic Hepatobiliary System & Pancreas Skin, Subcutaneous Tissue & Breast Blood and Immunology Injuries, Poisonings, & Drug Toxicity Ear, Nose, Mouth, & Throat Female Reproductive System Male Reproductive System Eye Multiple Significant Trauma Others (Burns, Myeloproliferative Diseases & Disorders, Human Immunodefiency Virus); Unknown
Discharge location	Home; Skilled Nursing Facility; Rehabilitation Facility
Length of stay during index hospitalization	<2; 2-3; 4-5; 6+
Number of hospitalizations in 12 months prior to index hospitalization	Continuous variable
Average days of hospitalization in 12 months prior to index hospitalization.	Continuous variable
Hospital teaching status	Teaching; Non-Teaching
Hospital bed size	Fewer than 100; 100-300; 300 or more
Hospital geographic location	Urban; Rural
Hospital tax status	For-profit; Non-for-profit
Hospital staffing level	Based on Hospital level Quartiles: Hospital staffing was measured as the ratio of registered nurse hours per adjusted patient day.
Hospital percentage of Medicaid inpatient days	Based on Hospital level Quartiles
Hospital average length of stay	Based on Hospital level Quartiles

Appendix Table 2. Characteristics of Discharges by Medicare Program and Number of Chronic Conditions, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (N=102,556).

	Overall	Number of Chronic Conditions												p
		0-1		2-3		4-5		6-7		8-9		10+		
		FFS	MA	FFS	MA	FFS	MA	FFS	MA	FFS	MA	FFS	MA	
N	102556	13003	5925	21575	8332	18499	5778	12992	3229	7209	1430	3959	625	
Age (%)														<0.001
66-69	16.4	21.5	21.6	16.4	16.8	13.8	13.8	13.8	13.9	16	14.7	18.7	16.6	
70-74	19.6	21.6	24.1	19.5	22.4	17.8	19	17	18.4	18	19.4	22.1	20.8	
75-79	19.6	18.9	21	19	21	19	21	19.2	20.6	19.5	21.5	21	22.4	
80-84	18.8	15.3	16.5	18.2	18.6	19.8	20.7	20.1	22	19.9	21.7	18.7	20.2	
85-89	13.2	10.8	9.7	13	11.7	14.5	14.1	15	15.1	14.8	13.6	11.8	15.7	
90+	12.4	11.7	7	13.8	9.6	15.1	11.2	14.9	10.1	11.7	9.2	7.7	4.3	
Gender = Female (%)	57.3	54.8	52.1	58.2	54.5	58.5	54.2	59.3	53.5	60.2	53.4	65.4	58.7	<0.001
Residence = Rural (%)	13	14.4	15.3	13.7	15.1	12.4	14.3	11.2	13.1	10.7	10.3	8.3	10.7	<0.001
Hospice = Hospice (%)	2.6	1.4	0	2.3	0	3.5	0	5.4	0	5.5	0	5.1	0	<0.001
Length of Stay (%)														<0.001
<2	11.1	13.6	16.4	11.9	14.9	9.7	12.2	8.2	9.7	7.2	7.3	6.9	6.4	
2-3	42.9	50.6	52.3	45.3	45.4	41.5	41	38	36.4	35.9	35.8	33.3	28.8	
4-5	23.2	19.8	17.6	22.9	20.8	24.9	23.6	26.2	24.2	25.1	25	24.8	27.4	
6+	22.9	16	13.8	19.9	18.9	23.9	23.1	27.7	29.8	31.8	31.8	35	37.4	
Number of Hospitalizations[a] (mean (sd))	0.86 (1.37)	0.09 (0.33)	0.11 (0.37)	0.31 (0.60)	0.36 (0.72)	0.77 (0.94)	0.88 (1.05)	1.41 (1.29)	1.57 (1.44)	2.19 (1.76)	2.37 (1.86)	3.37 (2.67)	3.14 (1.94)	<0.001
Avg Days of Hospitalizations[b] (mean (sd))	2.32 (4.39)	0.25 (1.08)	0.33 (1.59)	1.00 (2.48)	1.11 (2.98)	2.45 (3.87)	2.88 (5.57)	3.99 (4.93)	4.69 (7.65)	5.05 (5.19)	5.77 (7.34)	6.07 (5.85)	7.14 (8.22)	<0.001
Principle Diagnosis for Index Hospitalization (%)														<0.001
Circulatory System	23	19.4	20.6	22.1	23.4	22.9	25.3	24.5	27.5	25.5	27.7	24.7	27.7	
Musculoskeletal System &	18.3	30.6	33.2	22.4	24.1	14.7	13.8	10.2	8.6	7.1	6.6	6.5	6.4	

Connective Tissue														
Respiratory System	12.3	7.4	7.1	10.8	11.5	14.2	14.2	15.3	15.4	15.7	15.1	15.3	13.3	
Digestive System	11.1	10.6	11.6	11	11.1	11	11.9	11	12	11.5	12.3	10.5	13.9	
Kidney & Urinary Tract	7.1	4.8	4.3	5.6	4.9	7.9	7.7	9	9.1	10.4	9	11.7	10.6	
Nervous System	6.9	8.8	8.8	7.6	8.4	6.6	6.7	5.2	5	4.7	5.4	5.2	3.5	
Infectious & Parasitic Diseases	6.8	4.6	4.3	5.7	6	7.4	7.5	8.5	8.8	9	9.2	8.9	10.6	
Factors Influencing Health Status	2.8	1.7	1.7	2.4	2	3.1	2.9	3.5	3.7	3.7	3.9	4.1	2.9	
Endocrine, Nutritional, & Metabolic	3	4	0.4	3.8	0.6	3.9	0.8	3.8	0.5	3.4	0.7	3.1	0.6	
Hepatobiliary System & Pancreas	2.1	2.4	2.8	2.3	2.3	1.9	2.1	1.7	1.9	1.5	2.3	2.1	2.2	
Skin, Subcutaneous Tissue & Breast	2.1	1.7	1.2	2	1.8	2	2.1	2.7	2.2	2.6	2.6	2.3	2.4	
Blood and Immunology	1.2	0.7	0.6	1.1	1	1.3	1.6	1.4	1.5	1.8	1.8	2.3	1.3	
Injuries, Poisonings, & Drug Toxicity	0.9	0.6	0.6	0.9	0.8	1	1	0.9	1.4	1	1.3	1.4	1.9	
Ear, Nose, Mouth, & Throat	0.7	0.8	0.7	0.7	0.5	0.7	0.7	0.6	0.8	0.6	0.3	0.5	0.8	
Female Reproductive System	0.3	0.5	0.5	0.3	0.4	0.2	0.1	0.2	0.2	0.2	0	0.2	0.2	
Male Reproductive System	0.3	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.3	0.1	0	
Eye	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0	0	
Multiple Significant Trauma	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0	0.1	0.3	
Others	0	0	0	0	0.1	0.1	0	0.1	0	0	0.1	0	0	
Unknown	0.8	0.6	0.8	0.7	0.8	0.8	1.1	0.9	1.1	1	1	1.2	1.4	
Discharge Location (%)														<0.001
Home	71.4	75.4	80.4	71.9	77.2	68.8	74.7	66.3	72.1	66.3	69.7	62.4	67.2	
SNF	25.9	22.1	15.8	25.7	18.4	28.8	20.9	31.7	23.8	31.8	24.5	35.4	28.2	
Rehab	2.8	2.6	3.8	2.4	4.4	2.4	4.4	2	4.1	1.9	5.9	2.1	4.6	
Hospital Teaching Status =	54.4	51.1	50.1	53.5	52.7	55	54.2	56.9	55.5	58.1	58.5	59.6	58.1	<0.001

Teaching (%)														
Hospital Bed Size (%)														<0.001
Fewer than 100	21.5	24.5	23.6	21.9	21.7	21.3	21.3	20.2	19.9	19.5	17.2	18	13.9	
100-300	47.9	46.8	57.4	46.8	57.5	45.7	54.4	44.7	52.7	42	56	37.1	50.6	
300 or more	30.6	28.7	19	31.2	20.9	33	24.3	35	27.3	38.5	26.8	44.8	35.5	
Hospital Location = Rural (%)	14.1	14	14.2	14	14.9	14	16.6	13.6	17	13	12.7	11.7	13.9	<0.001
Hospital Tax Status = For-profit (%)	0.9	2.1	2	1.3	1	0.5	0.3	0.2	0.1	0.1	0.1	0	0.2	<0.001
Hospital Average Length of Stay (%)														<0.001
Q1	10.7	14.3	14.3	11.6	11	9.9	10.2	8.7	10	8.3	7.3	6.1	6.2	
Q2	17.2	16.2	24	15.3	24	15.5	23.8	15.3	20.2	13.8	18	13.8	13.4	
Q3	25.9	24.1	31.9	24.6	33.4	24.5	30.7	23.7	29.6	22.7	28.4	21	27.7	
Q4	46.3	45.3	29.7	48.5	31.5	50	35.3	52.3	40.2	55.1	46.3	59.1	52.6	
Hospital Percentage of Medicaid Inpatient Days (%)														<0.001
Q1	20.9	23.3	24.2	21.2	23.8	20.1	22.3	19.5	20.4	17	21.4	15.4	17.6	
Q2	20.2	19	24.4	18.4	23.9	19.6	24.6	18.8	24.3	19.7	21.8	18.1	18.9	
Q3	31.6	34	16.3	35.7	16.5	35.4	16.7	36.4	19	39.5	21.7	44.3	25.9	
Q4	27.3	23.7	35.1	24.8	35.9	24.9	36.4	25.3	36.3	23.7	35.1	22.2	37.6	
Hospital Staff Level (%)														<0.001
Q1	16.2	15.3	23.4	14.8	22.6	14.7	22.7	13.1	21.2	12.8	18.6	10.9	16.8	
Q2	20.2	17.4	27.1	18.4	26.7	18.1	25.5	17.9	27.3	17.4	30.1	18.4	28.5	
Q3	34.6	34.1	26.6	35.2	27.2	36.8	26.5	39.8	27.6	40.5	27.7	42.3	34.6	
Q4	29.1	33.2	22.9	31.6	23.6	30.4	25.3	29.2	23.8	29.3	23.6	28.4	20.2	

[a]Number of hospitalizations in 12 months prior to index hospitalization.

[b]Average days of hospitalization in 12 months prior to index hospitalization.

Note: Avg=Average; FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Appendix Table 3. Prevalence of Most Common Single, Dyads, and Triads of Chronic Conditions among Patients who Experienced a Hospital Readmission by Medicare Program.

Single Chronic Conditions (N=FFS: 9259; MA: 2493)

Rank	Top 10 Single Conditions in FFS	FFS (%)	MA (%)	P-value	Top 10 Single Conditions in MA	FFS (%)	MA (%)	P-value
1	Hypertension	75.3	75.1	0.841	Hypertension	75.3	75.1	0.841
2	Fluid/Electrolyte Disorders	44.9	36.9	<0.01	Congestive Heart Failure	43.4	39.4	<0.01
3	Deficiency Anemia	44.6	38.3	<0.01	Deficiency Anemia	44.6	38.3	<0.01
4	Congestive Heart Failure	43.4	39.4	<0.01	Renal Failure	41.8	38.1	0.001
5	Renal Failure	41.8	38.1	0.001	Fluid/Electrolyte Disorders	44.9	36.9	<0.01
6	Chronic Pulmonary Disease	38.8	36.7	0.059	Chronic Pulmonary Disease	38.8	36.7	0.059
7	Peripheral Vascular Disease	32	25.9	<0.01	Peripheral Vascular Disease	32	25.9	<0.01
8	Hypothyroidism	25.1	19.7	<0.01	Hypothyroidism	25.1	19.7	<0.01
9	Diabetes, complicated	22.8	18.5	<0.01	Diabetes, complicated	22.8	18.5	<0.01
10	Valvular Disease	21.2	17.4	<0.01	Diabetes, uncomplicated	18.6	17.5	0.232

Dyads of Chronic Conditions (N=FFS: 9259; MA: 2493)

Rank	Top 10 Dyads in FFS	FFS (%)	MA (%)	P-value	Top 10 Dyads in MA	FFS (%)	MA (%)	P-value
1	Hypertension; Fluid/Electrolyte Disorders	39.3	33.4	<0.01	Hypertension	37.4	35	0.031
2	Deficiency Anemia; Hypertension	38.4	34.3	<0.01	Congestive Heart Failure	38.4	34.3	<0.01
3	Congestive Heart Failure; Hypertension	37.5	33.9	0.002	Deficiency Anemia	37.5	33.9	0.002
4	Hypertension; Renal Failure	37.4	35	0.031	Renal Failure	39.3	33.4	<0.01
5	COPD; Hypertension	32	31.3	0.521	Fluid/Electrolyte Disorders	32	31.3	0.521
6	Deficiency Anemia; Fluid/Electrolyte Disorders	29.8	22.6	<0.01	Chronic Pulmonary Disease	28.1	24.2	<0.01
7	Deficiency Anemia; Renal Failure	28.1	24.2	<0.01	Peripheral Vascular Disease	27.7	24	<0.01
8	Congestive Heart Failure; Renal Failure	27.7	24	<0.01	Hypothyroidism	26.8	23.1	<0.01
9	Hypertension; Peripheral Vascular Disease	26.8	23.1	<0.01	Diabetes, complicated	29.8	22.6	<0.01
10	Deficiency Anemia; Fluid/Electrolyte Disorders	26.8	21	<0.01	Diabetes, uncomplicated	26.4	21.3	<0.01

Triads of Chronic Conditions (N=FFS: 7,852; MA: 1,989)

Rank	Top 10 Triads in FFS	FFS (%)	MA (%)	P-value	Top 10 Triads in MA	27.6	24.8	0.011
1	Deficiency Anemia Hypertension Fluid/Electrolyte Disorders	28.3	22.8	<0.01	Deficiency Anemia Hypertension Renal Failure	27.1	24.3	0.013
2	Deficiency Anemia Hypertension Renal Failure	27.6	24.8	0.011	Congestive Heart Failure Hypertension Renal Failure	28.3	22.8	<0.01
3	Congestive Heart Failure Hypertension	27.1	24.3	0.013	Deficiency Anemia Hypertension	25.8	21.9	<0.01

	Renal Failure				Fluid/Electrolyte Disorders			
4	Congestive Heart Failure Hypertension Fluid/Electrolyte Disorders	25.8	20.3	<0.01	Hypertension Fluid/Electrolyte Disorders Renal Failure	25.4	20.7	<0.01
5	Hypertension Fluid/Electrolyte Disorders Renal Failure	25.8	21.9	<0.01	Deficiency Anemia Congestive Heart Failure Hypertension	25.8	20.3	<0.01
6	Deficiency Anemia Congestive Heart Failure Hypertension	25.4	20.7	<0.01	Congestive Heart Failure Hypertension Fluid/Electrolyte Disorders	21.4	18.1	0.001
7	Congestive Heart Failure Chronic Pulmonary Disease Hypertension	21.4	18.1	0.001	Congestive Heart Failure Chronic Pulmonary Disease Hypertension	20.1	17.4	0.006
8	Deficiency Anemia Congestive Heart Failure Renal Failure	21.1	17	<0.01	Chronic Pulmonary Disease Hypertension Fluid/Electrolyte Disorders	18.1	17.1	0.358
9	Deficiency Anemia Fluid/Electrolyte Disorders Renal Failure	21.1	16.6	<0.01	Chronic Pulmonary Disease Hypertension Renal Failure	21.1	17	<0.01
10	Deficiency Anemia Congestive Heart Failure Fluid/Electrolyte Disorders	20.7	14.9	<0.01	Deficiency Anemia Congestive Heart Failure Renal Failure	27.6	24.8	0.011

Note: Single chronic condition included patients with one or more chronic condition; Dyads of chronic conditions included patients with two or more chronic conditions; Triads of chronic conditions included patients with three or more chronic conditions; FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Appendix Table 4. Prevalence of Most Common Single, Dyads, and Triads of Chronic Conditions by Medicare Program.

Single Chronic Conditions (N=FFS: 9259; MA: 2493)

Rank	Top 10 Single Conditions in FFS	FFS (%)	MA (%)	P-value	Top 10 Single Conditions in MA	FFS (%)	MA (%)	P-value
1	Hypertension	75.3	75.1	0.841	Hypertension	75.3	75.1	0.841
2	Fluid/Electrolyte Disorders	44.9	36.9	<0.01	Congestive Heart Failure	43.4	39.4	<0.01
3	Deficiency Anemia	44.6	38.3	<0.01	Deficiency Anemia	44.6	38.3	<0.01
4	Congestive Heart Failure	43.4	39.4	<0.01	Renal Failure	41.8	38.1	0.001
5	Renal Failure	41.8	38.1	0.001	Fluid/Electrolyte Disorders	44.9	36.9	<0.01
6	Chronic Pulmonary Disease	38.8	36.7	0.059	Chronic Pulmonary Disease	38.8	36.7	0.059
7	Peripheral Vascular Disease	32	25.9	<0.01	Peripheral Vascular Disease	32	25.9	<0.01
8	Hypothyroidism	25.1	19.7	<0.01	Hypothyroidism	25.1	19.7	<0.01
9	Diabetes, complicated	22.8	18.5	<0.01	Diabetes, complicated	22.8	18.5	<0.01
10	Valvular Disease	21.2	17.4	<0.01	Diabetes, uncomplicated	18.6	17.5	0.232

Dyads of Chronic Conditions (N=FFS: 9259; MA: 2493)

Rank	Top 10 Dyads in FFS	FFS (%)	MA (%)	P-value	Top 10 Dyads in MA	FFS (%)	MA (%)	P-value
1	Hypertension; Fluid/Electrolyte Disorders	39.3	33.4	<0.01	Hypertension	37.4	35	0.031
2	Deficiency Anemia; Hypertension	38.4	34.3	<0.01	Congestive Heart Failure	38.4	34.3	<0.01
3	Congestive Heart Failure; Hypertension	37.5	33.9	0.002	Deficiency Anemia	37.5	33.9	0.002
4	Hypertension; Renal Failure	37.4	35	0.031	Renal Failure	39.3	33.4	<0.01
5	COPD; Hypertension	32	31.3	0.521	Fluid/Electrolyte Disorders	32	31.3	0.521
6	Deficiency Anemia; Fluid/Electrolyte Disorders	29.8	22.6	<0.01	Chronic Pulmonary Disease	28.1	24.2	<0.01
7	Deficiency Anemia; Renal Failure	28.1	24.2	<0.01	Peripheral Vascular Disease	27.7	24	<0.01
8	Congestive Heart Failure; Renal Failure	27.7	24	<0.01	Hypothyroidism	26.8	23.1	<0.01
9	Hypertension; Peripheral Vascular Disease	26.8	23.1	<0.01	Diabetes, complicated	29.8	22.6	<0.01
10	Deficiency Anemia; Fluid/Electrolyte Disorders	26.8	21	<0.01	Diabetes, uncomplicated	26.4	21.3	<0.01

Triads of Chronic Conditions (N=FFS: 7,852; MA: 1,989)

Rank	Top 10 Triads in FFS	FFS (%)	MA (%)	P-value	Top 10 Triads in MA	27.6	24.8	0.011
1	Deficiency Anemia Hypertension Fluid/Electrolyte Disorders	28.3	22.8	<0.01	Deficiency Anemia Hypertension Renal Failure	27.1	24.3	0.013
2	Deficiency Anemia Hypertension Renal Failure	27.6	24.8	0.011	Congestive Heart Failure Hypertension Renal Failure	28.3	22.8	<0.01
3	Congestive Heart Failure Hypertension	27.1	24.3	0.013	Deficiency Anemia Hypertension	25.8	21.9	<0.01

	Renal Failure				Fluid/Electrolyte Disorders			
4	Congestive Heart Failure Hypertension Fluid/Electrolyte Disorders	25.8	20.3	<0.01	Hypertension Fluid/Electrolyte Disorders Renal Failure	25.4	20.7	<0.01
5	Hypertension Fluid/Electrolyte Disorders Renal Failure	25.8	21.9	<0.01	Deficiency Anemia Congestive Heart Failure Hypertension	25.8	20.3	<0.01
6	Deficiency Anemia Congestive Heart Failure Hypertension	25.4	20.7	<0.01	Congestive Heart Failure Hypertension Fluid/Electrolyte Disorders	21.4	18.1	0.001
7	Congestive Heart Failure Chronic Pulmonary Disease Hypertension	21.4	18.1	0.001	Congestive Heart Failure Chronic Pulmonary Disease Hypertension	20.1	17.4	0.006
8	Deficiency Anemia Congestive Heart Failure Renal Failure	21.1	17	<0.01	Chronic Pulmonary Disease Hypertension Fluid/Electrolyte Disorders	18.1	17.1	0.358
9	Deficiency Anemia Fluid/Electrolyte Disorders Renal Failure	21.1	16.6	<0.01	Chronic Pulmonary Disease Hypertension Renal Failure	21.1	17	<0.01
10	Deficiency Anemia Congestive Heart Failure Fluid/Electrolyte Disorders	20.7	14.9	<0.01	Deficiency Anemia Congestive Heart Failure Renal Failure	27.6	24.8	0.011

Note: Single chronic condition included patients with one or more chronic condition; Dyads of chronic conditions included patients with two or more chronic conditions; Triads of chronic conditions included patients with three or more chronic conditions; FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Single Chronic Conditions (n=FFS: 72,664; MA: 23,239)

Rank	Top 10 Single Conditions in FFS	FFS (%)	MA (%)	P-value	Top 10 Single Conditions in MA	FFS (%)	MA (%)	P-value
1	Hypertension	75.9	74.6	<0.01	Hypertension	75.9	74.6	<0.01
2	Deficiency Anemia	31.9	24.3	<0.01	Chronic Pulmonary Disease	31	27.2	<0.01
3	Fluid/Electrolyte Disorders	31.2	24.5	<0.01	Renal Failure	29.9	26.3	<0.01
4	Chronic Pulmonary Disease	31	27.2	<0.01	Congestive Heart Failure	30	25	<0.01
5	Congestive Heart Failure	30	25	<0.01	Fluid/Electrolyte Disorders	31.2	24.5	<0.01
6	Renal Failure	29.9	26.3	<0.01	Deficiency Anemia	31.9	24.3	<0.01
7	Peripheral Vascular Disease	27.3	20.2	<0.01	Peripheral Vascular Disease	27.3	20.2	<0.01
8	Hypothyroidism	23.1	17.5	<0.01	Diabetes, uncomplicated	19.5	18.7	0.012
9	Diabetes, uncomplicated	19.5	18.7	0.012	Hypothyroidism	23.1	17.5	<0.01
10	Neurological Disorders	17.8	13.1	<0.01	Diabetes, complicated	17.2	14.1	<0.01

Dyads of Chronic Conditions (n=FFS: 64,313; MA: 19,424)

Rank	Top 10 Dyads of Conditions in FFS	FFS (%)	MA (%)	P-value	Top 10 Dyads of Conditions in MA	FFS (%)	MA (%)	P-value
1	Hypertension Fluid/Electrolyte Disorders	29.4	24	<0.01	Hypertension Renal Failure	28	25.4	<0.01
2	Deficiency Anemia Hypertension	29.3	23.3	<0.01	Chronic Pulmonary Disease Hypertension	27.4	24.8	<0.01
3	Hypertension Renal Failure	28	25.4	<0.01	Hypertension Fluid/Electrolyte Disorders	29.4	24	<0.01
4	Congestive Heart Failure Hypertension	27.8	23.7	<0.01	Congestive Heart Failure Hypertension	27.8	23.7	<0.01
5	Chronic Pulmonary Disease Hypertension	27.4	24.8	<0.01	Deficiency Anemia Hypertension	29.3	23.3	<0.01
6	Hypertension Peripheral Vascular Disease	24.4	19	<0.01	Hypertension Peripheral Vascular Disease	24.4	19	<0.01
7	Hypertension Hypothyroidism	20	15.3	<0.01	Diabetes, uncomplicated Hypertension	17.3	17.3	<0.01
8	Deficiency Anemia Fluid/Electrolyte Disorders	19	13.1	<0.01	Hypertension Hypothyroidism	20	15.3	<0.01
9	Deficiency Anemia Renal Failure	18.7	14.4	<0.01	Congestive Heart Failure Renal Failure	17.6	14.5	<0.01
10	Congestive Heart Failure Renal Failure	17.6	14.5	<0.01	Deficiency Anemia Renal Failure	18.7	14.4	<0.01

Triads of Chronic Conditions (n=FFS: 53,465; MA: 15,066)

Rank	Top 10 Triads of Conditions in FFS	FFS (%)	MA (%)	P-value	Top 10 Triads of Conditions in MA	FFS (%)	MA (%)	P-value
1	Deficiency Anemia Hypertension Renal Failure	19.8	16.1	<0.01	Congestive Heart Failure Hypertension Renal Failure	18.7	16.2	<0.01
2	Deficiency Anemia Hypertension Fluid/Electrolyte Disorders	19.7	14.6	<0.01	Deficiency Anemia Hypertension Renal Failure	19.8	16.1	<0.01
3	Congestive Heart Failure Hypertension Renal Failure	18.7	16.2	<0.01	Deficiency Anemia Hypertension Fluid/Electrolyte Disorders	19.7	14.6	<0.01
4	Hypertension Fluid/Electrolyte Disorders Renal Failure	17.7	14.2	<0.01	Hypertension Fluid/Electrolyte Disorders Renal Failure	17.7	14.2	<0.01
5	Congestive Heart Failure Hypertension Fluid/Electrolyte Disorders	17.5	13.5	<0.01	Congestive Heart Failure Hypertension Fluid/Electrolyte Disorders	17.5	13.5	<0.01
6	Deficiency Anemia Congestive Heart Failure Hypertension	17.4	13.3	<0.01	Deficiency Anemia Congestive Heart Failure Hypertension	17.4	13.3	<0.01
7	Congestive Heart Failure Chronic Pulmonary Disease Hypertension	15.6	12.6	<0.01	Congestive Heart Failure Chronic Pulmonary Disease Hypertension	15.6	12.6	<0.01
8	Chronic Pulmonary Disease Hypertension Fluid/Electrolyte Disorders	14.6	12.3	<0.01	Chronic Pulmonary Disease Hypertension Fluid/Electrolyte Disorders	14.6	12.3	<0.01
9	Deficiency Anemia Chronic Pulmonary Disease Hypertension	13.7	10.7	<0.01	Chronic Pulmonary Disease Hypertension Renal Failure	13	11.2	<0.01
10	Deficiency Anemia Fluid/Electrolyte Disorders	13.5	9.6	<0.01	Deficiency Anemia Chronic Pulmonary Disease	13.7	10.7	<0.01

Renal Failure	Hypertension

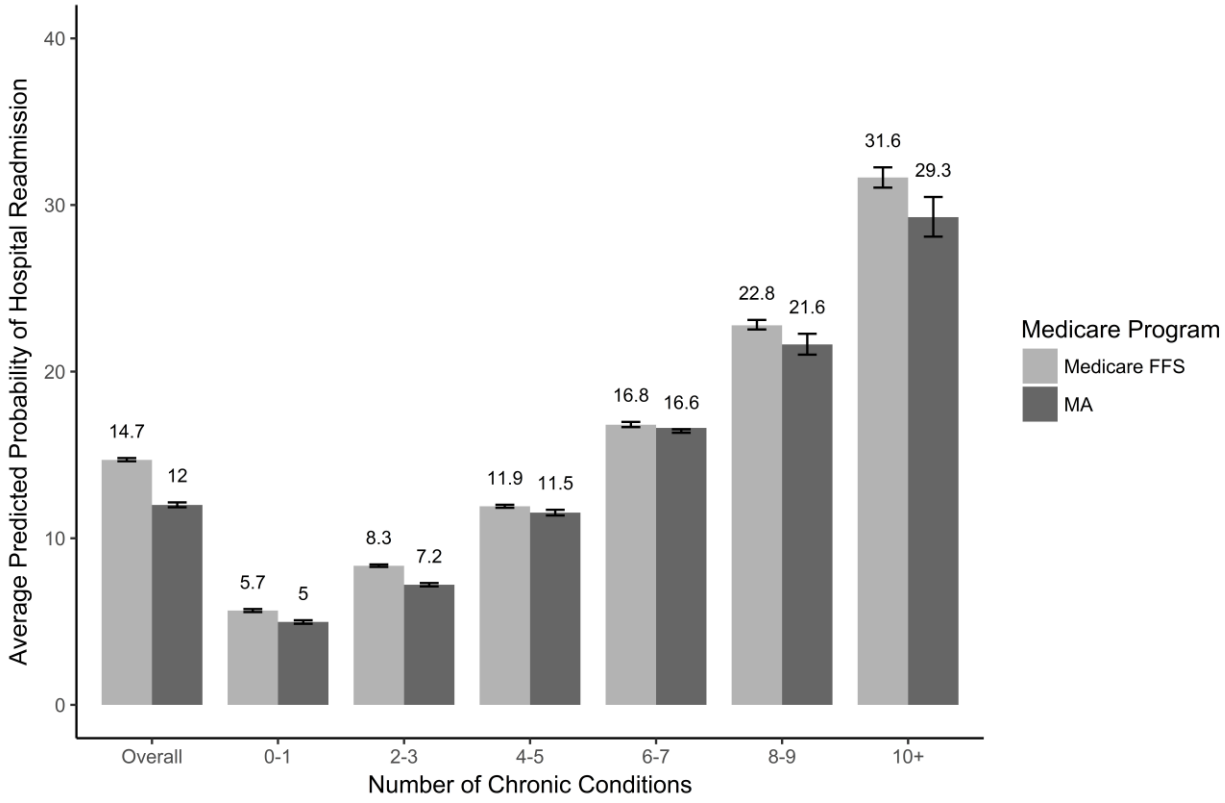
Note: Single chronic condition included patients with one or more chronic condition; Dyads of chronic conditions included patients with two or more chronic conditions; Triads of chronic conditions included patients with three or more chronic conditions; FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Appendix Table 5. Number of Chronic Conditions Distribution between Medicare Fee-for-Service and Medicare Advantage by Using Different Data Timeframe, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (N=102,556).

	12 Months Data		Whole Data	
	FFS	MA	FFS	MA
N	77,237	25,319	77,237	25,319
Number of Chronic Conditions (%)				
0-1	16.8	23.4	6.3	10.4
2-3	27.9	32.9	21.7	29
4-5	24	22.8	28.7	30
6-7	16.8	12.8	23.1	18.9
8-9	9.3	5.6	13.1	8.2
10 or more	5.1	2.5	7.1	3.5

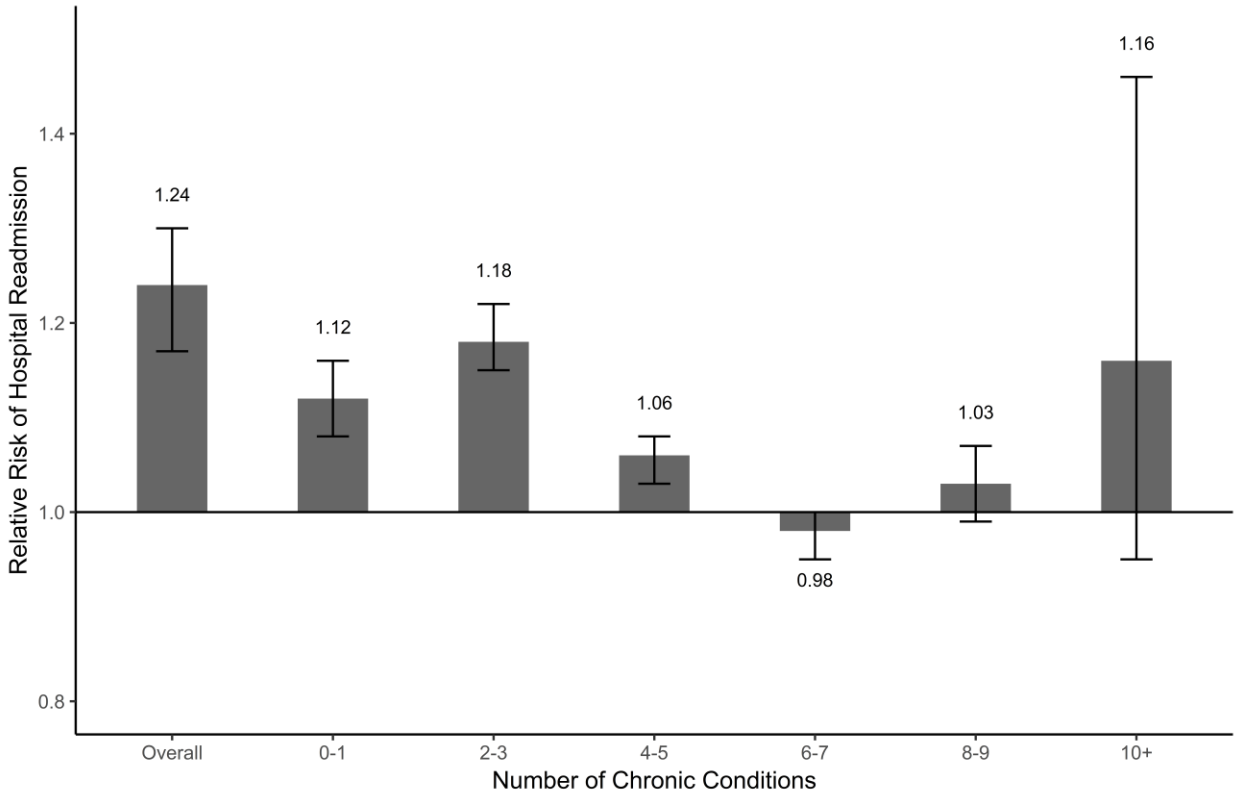
Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Appendix Figure 1. Predicted Probabilities of 30-Day Hospital Readmission by Medicare Program and Number of Chronic Conditions using Whole Data to define Chronic Conditions.



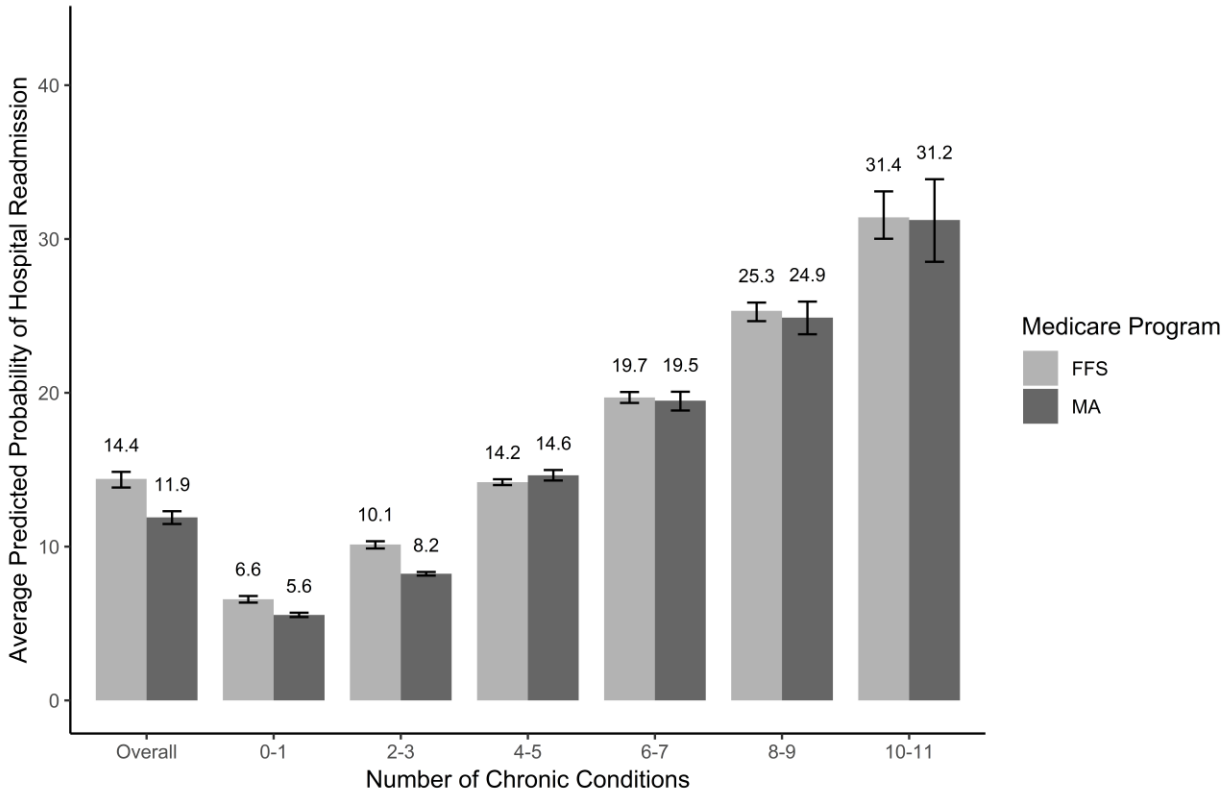
Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Appendix Figure 2. Relative Risks of 30-Day Hospital Readmission between Medicare Fee-for-Service and Medicare Advantage by Number of Chronic Conditions using Whole Data to define Chronic Conditions.



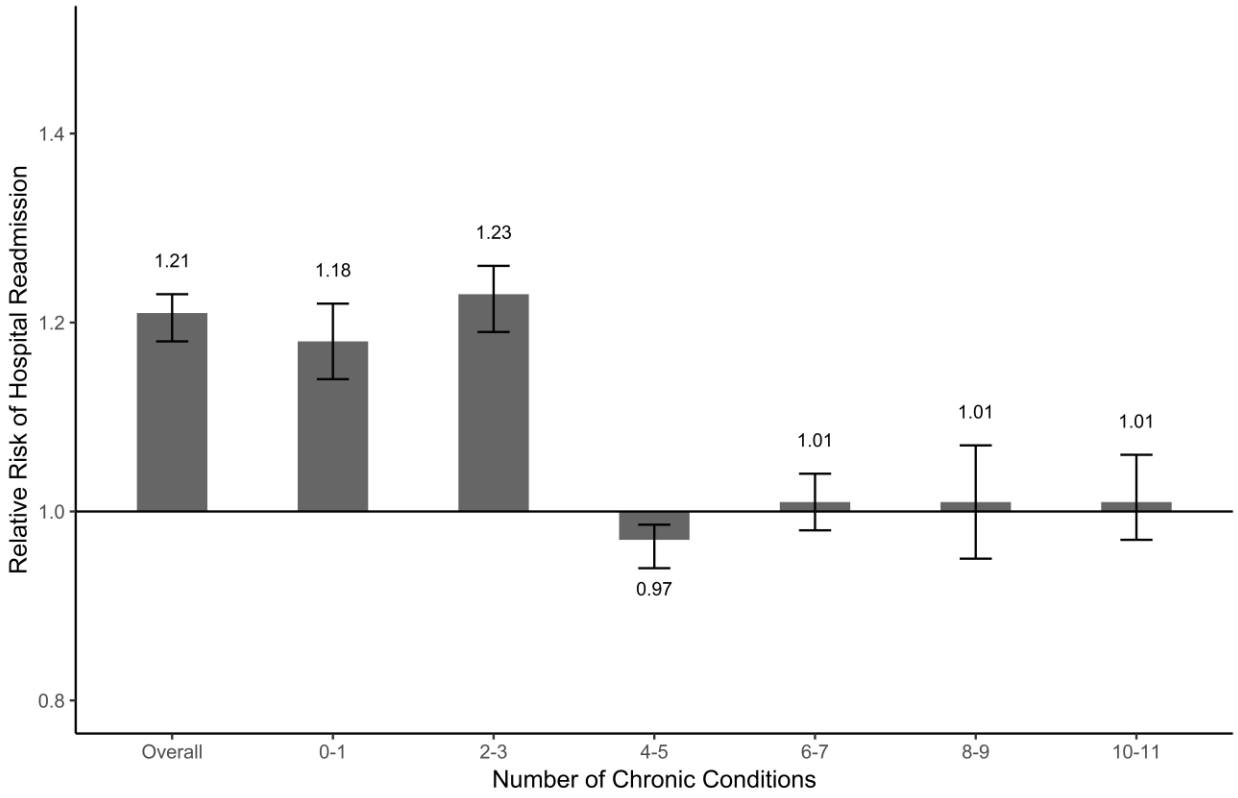
Note: Relative risk was calculated based on probability of readmission in Medicare Fee-for-Service as numerator and risk of readmission in Medicare Advantage as denominator.

Appendix Figure 3. Predicted Probabilities of 30-Day Hospital Readmission by Medicare Program and Number of Chronic Conditions, Excluded Patients with 12 or More Chronic Conditions.



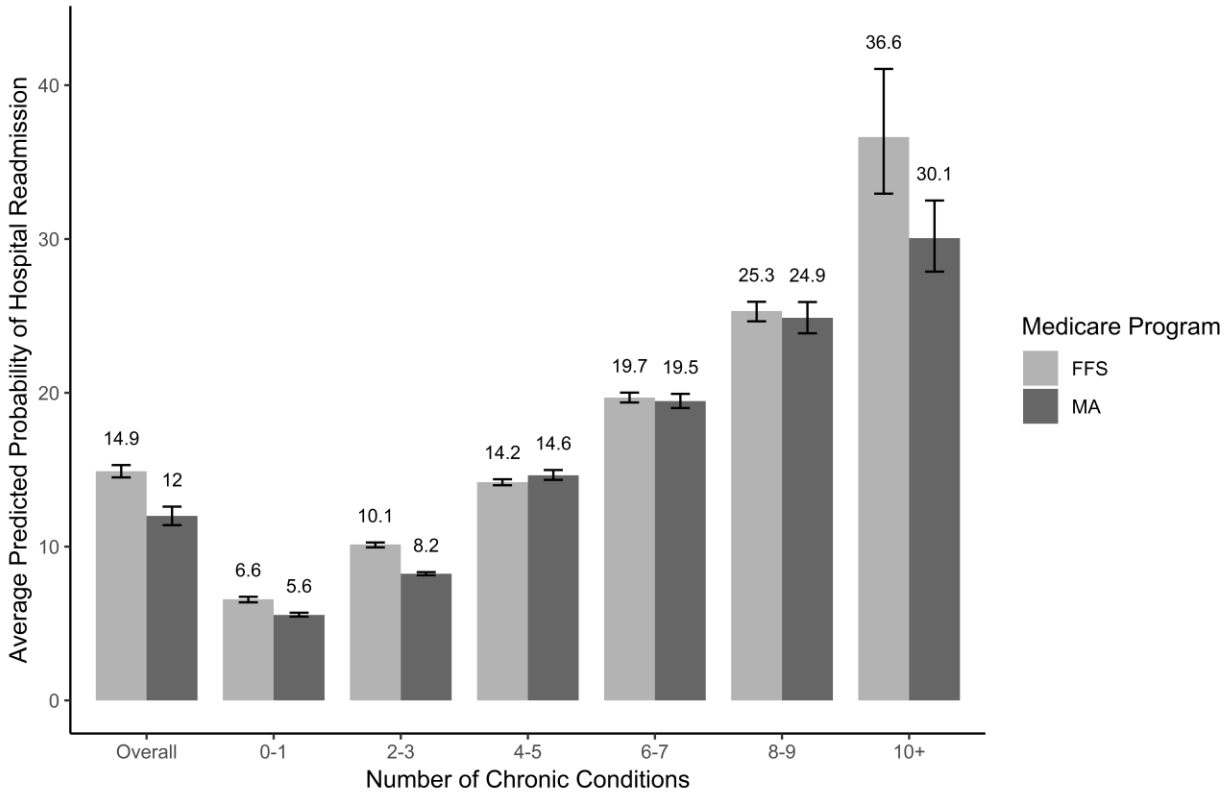
Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Appendix Figure 4. Relative Risks of 30-Day Hospital Readmission between Medicare Fee-for-Service and Medicare Advantage by Number of Chronic Conditions, Excluded Patients with 12 or More Chronic Conditions.



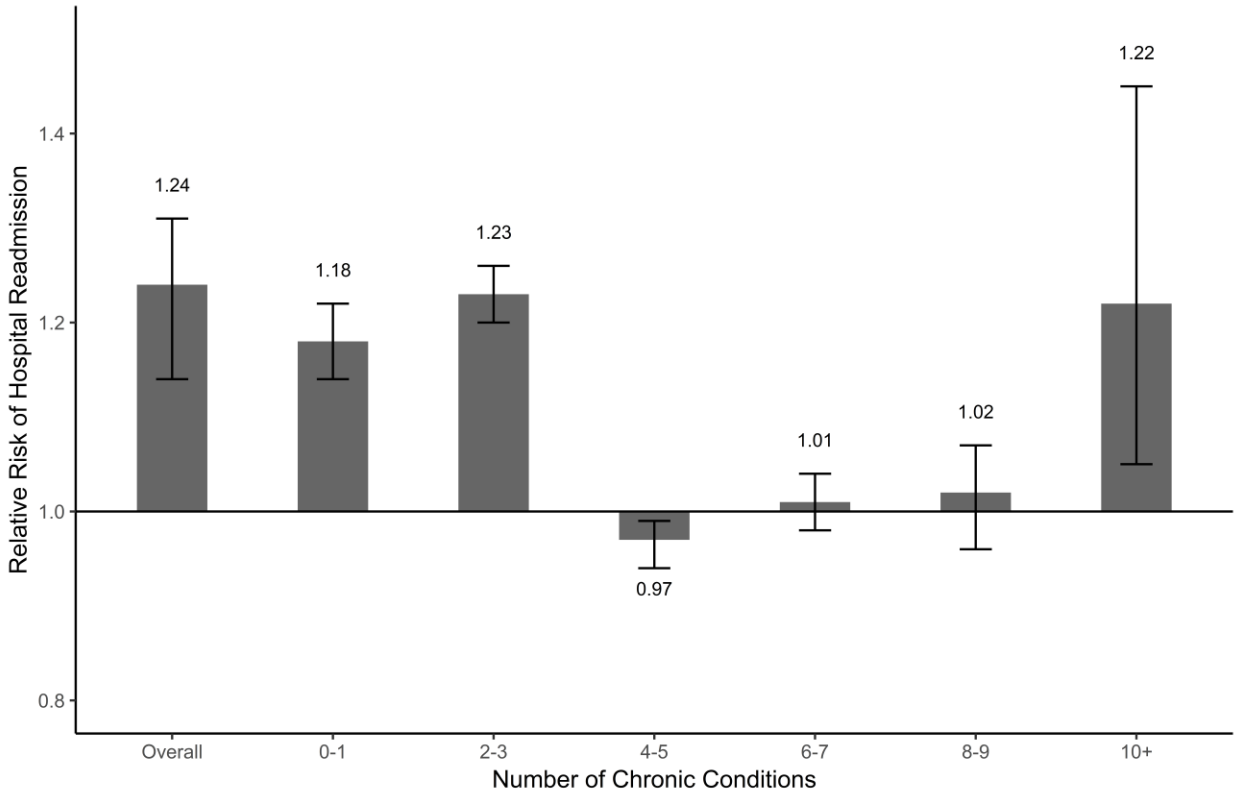
Note: Relative risk was calculated based on probability of readmission in Medicare Fee-for-Service as numerator and risk of readmission in Medicare Advantage as denominator.

Appendix Figure 5. Predicted Probabilities of 30-Day Hospital Readmission by Medicare Program and Number of Chronic Conditions without Adjusting Age.



Note: FFS=Medicare Fee-for-Service; MA=Medicare Advantage.

Appendix Figure 6. Relative Risks of 30-Day Hospital Readmission between Medicare Fee-for-Service and Medicare Advantage by Number of Chronic Conditions without Adjusting Age.



Note: Relative risk was calculated based on probability of readmission in Medicare Fee-for-Service as numerator and risk of readmission in Medicare Advantage as denominator.

Chapter 4

Association between Outpatient Physician Follow-Up Visits within 7 days after Discharge and All-Cause 7-Day Readmissions in Medicare

ABSTRACT

Background. Outpatient follow-up visits within 7 days after discharge have been promoted as a method to reduce readmission rates, however, previous studies have shown inconclusive results on the association between follow-up visits and readmissions.

Objective. To examine the association between outpatient follow-up visits within 7 days and 7-day readmissions among Medicare beneficiaries.

Research Design. Using Wisconsin Health Information Organization all payer claims database which covers 2012 to 2014, we compared the unadjusted 7-day readmission rate by follow-up visits within 7 days and by Medicare program.

Results. Forty percent of patients had a follow-up visit within 7 days after discharge in Medicare, and visit rates varied substantially across patients' discharge hospitals (8 to 62.5%). Patients with follow-up visits within 7 days were associated with longer length of hospitalization, more hospitalization before the index hospitalization, and more chronic conditions. Follow-up visits within 7 days were associated with 0.54 times lower 7-day readmission rates compared to those without follow-up visits. We found differences in readmission rates between Medicare FFS and MA among patients without a follow-up visit, but not among patients with follow-up visits.

Conclusion. Six out of 10 Medicare beneficiaries do not have a follow-up visit with a physician within 7 days after discharge. Greater efforts to promote follow-up visits within 7 days may reduce all-cause readmissions in Medicare.

INTRODUCTION

Hospital readmissions within 30-days of discharge in Medicare Fee-for-Service (FFS) has declined from 17.7 percent in 2011 to 15.8 percent in 2016 (MedPAC, 2018), however, a large proportion of hospital readmissions in Medicare are considered potentially avoidable (MedPAC, 2007). Reducing readmissions in Medicare is important to improve patients' and families' health and quality of life and to reduce the economic burden both in Medicare and U.S. health care system. The Centers for Medicare and Medicaid Services (CMS) has several initiatives to reduce readmissions in Medicare such as Hospital Readmission Reduction Program (Boccuti & Casillas, 2017). Professional societies and transitional care models have promoted outpatient physician follow-up visits within 7 days after discharge as a method to prevent readmissions (Dreyer, 2014). However, previous studies have shown inconclusive results on the association between follow-up visits and readmissions (Bradley et al., 2013; DeLia, Tong, Gaboda, & Casalino, 2014; Field, Ogarek, Garber, Reed, & Gurwitz, 2015; Hernandez, Greiner, Fonarow, & Al, 2010; Jackson, Shahsahebi, Wedlake, & DuBard, 2015; Kashiwagi, Burton, Kirkland, Cha, & Varkey, 2012; Koehler et al., 2009; Lin, Barnato, & Degenholtz, 2011; Tung, Chang, Chang, & Yu, 2017). Clarifying the relationship between post-discharge outpatient physician follow-up visits within 7 days and 7-day readmissions among Medicare beneficiaries could be important for informing hospital efforts to reduce readmissions in Medicare.

Post-discharge factors such as post-discharge outpatient physician follow-up visits have been promoted to reduce readmission rate by successful care transitions programs including Project RED (Re-engineered Discharge) and the Transitional Care Model (Jack et al., 2009; Mitchell et al., 2016; Tung et al., 2017). Also, various professional societies widely recommended follow-up visits after discharge from hospitalization to reduce the risk of

readmission (Lin et al., 2011). However, while several studies suggest patients with follow-up visits were associated with lower risk of readmission, but a number of studies have also demonstrated lack of association between follow-up visits and readmissions (Bradley et al., 2013; DeLia et al., 2014; Field et al., 2015; Hernandez et al., 2010; Jackson et al., 2015; Kashiwagi et al., 2012; Koehler et al., 2009; Lin et al., 2011; Tung et al., 2017). Clarifying the role of follow-up visits to reduce readmissions in Medicare is important to produce information about whether further effort to encourage follow-up visits after discharge is needed.

One reason the literature reports mixed findings may be that the relationship between follow-up visits and readmissions could be affected by bias such as time-dependent bias and selection bias. Time-dependent bias occurs when a time-dependent exposure is not correctly addressed in data analysis (Wolkewitz, Allignol, Schumacher, & Beyersmann, 2010). The typical approach of categorizing patients by follow-up visit as a binary variable could cause time-dependent bias (Sharma, Kuo, Freeman, Zhang, & Goodwin, 2010) because readmission after discharge but before a follow-up visit prevents patients from receiving follow-up care, and therefore those patients are classified to the no follow-up-visit group. This could overestimate the risk of readmission in the no follow-up visit group, and further inflate the benefit of follow-up visits. Also, it is also important to consider possible selection bias in follow-up visits within 7 days. There could be selection bias due to physicians wanting to check patients with more severe or medically less stable health conditions, who also have a greater risk of readmission, sooner after hospital discharge.[11,20] However, addressing these biases together is challenging with the current administrative data as each bias affects each other.

Therefore, we compared unadjusted 7-day readmission rate between patients with and without follow-up visits within 7 days by Medicare program among Medicare patients including

both Medicare FFS and Medicare Advantage (MA) in Wisconsin. Presenting the information by the two main programs for Medicare coverage would provide more information about follow-up visits in the context of Medicare and readmissions. Also, we stratified the analysis by age and number of chronic conditions, respectively, to produce helpful evidence that could support the role of follow-up visits within 7 days in readmission. The present study also estimated the cumulative incidence of follow-up visits.

METHODS

Data Sources

This study used linked data from the Wisconsin Health Information Organization (WHIO) all-payer claims database and American Hospital Association (AHA) annual Survey of Hospitals. We used data from WHIO all-payer claims database Version 13 of Datamart (DMV 13) which includes insurance claims data from October 2012 through December 2014. WHIO data is a voluntary statewide all-payer claims database which collects large sets of administrative claims and eligibility data from WHIO members through WHIO's data vendor twice annually. Each WHIO DMV contains 24 months of insurance claims data, collected over 27 months for completeness and refreshed approximately every 6 months. WHIO DMV 13 data contains more than 423 million medical, dental, and pharmaceutical claims from more than 4.8 million individuals which covers 75 percent of Wisconsin's population.

Study Population

This study focused on patients who were hospitalized in an acute care hospital in Wisconsin during October 2013 to September 2014. We focused on Medicare patients who are aged 66 years or older at the time of index hospitalization so that we could have claims data for 12-month look back to measure patients' characteristics, and alive upon discharge. We included

beneficiaries continuously enrolled in the same Medicare program for the 12 months prior to the index admission and continuously enrolled 30 days after discharge. This study excluded beneficiaries with potentially incomplete data due to railroad benefits. Patients transferred to another acute care hospital upon discharge or discharged against medical advice were excluded from this study. Readmissions that are considered as a planned readmission was also excluded by using the Yale formulation of all-cause readmissions (Horwitz et al., 20011). We also excluded patients discharged to a skilled nursing facility, rehabilitation facility, or hospice as these patients are monitored by healthcare professionals after discharge and the follow-up visits could not serve the same role as it does for patients who are discharged to home (Tong et al., 2018). The final study population consisted of 71,043 index hospitalizations from 66 hospital sites.

Readmission

The primary outcome of interest was 7-day all-cause hospital readmission. We defined readmission when Medicare beneficiaries age 66 or older were discharged from a hospitalization at a short-stay acute-care hospital and experienced an unplanned readmission for any cause to an acute care hospital within 7 days after discharge.

Follow-up Visits

Our main independent variable was follow-up visits within 7 days after discharge, defined as patients who had an outpatient visits with a physician within 7 days after discharge (Hernandez et al., 2010; Tung et al., 2017). We used outpatient evaluation and management visits to identify follow-up visits occurring within 7 days of discharge. We could only identify and include follow-up visits that occurred before a readmission.

Other Patient Characteristics

We stratified the analysis by age and number of chronic conditions. We categorized age in two groups: under 80 years old and 80 years or older. Using 12 months of claims data before the initial hospitalization, we categorized the number of chronic conditions as 0-1 versus 2 or more. We used the Elixhauser Comorbidity Method and dementia to define the number of chronic conditions (Elixhauser, Steiner, Harris, & Coffey, 1998; Taylor, Østbye, Langa, Weir, & Plassman, 2009; Weiner, Powe, Weller, Shaffer, & Anderson, 1998).

Statistical Analysis

We first compared the baseline characteristics of patients and hospitals stratified by follow-up visits within 7 days after discharge. We also described the unadjusted cumulative incidence of follow-up visits and hospital-level rates of follow-up visits within 7 days.

For the main analyses, we compare the unadjusted 7-day readmission rate between patients with and without follow-up visits in Medicare. Moreover, we compared how the association readmission rate and follow-up visits varies between Medicare programs. We also stratified the analysis by age and number of chronic conditions to assess whether the association varies by patients' characteristics. Statistical significance was defined as $p<0.05$ and we used R Studio 3.3.2 for the analyses.

As a sensitivity analysis, we conducted the main analysis with 14-day readmissions to examine whether the study results vary by the timeframe of readmission.

RESULTS

Table 1 shows the discharge characteristics stratified by patients with and without follow-up visits within 7 days. Four out of 10 patients completed outpatient follow-up visits within 7

days after discharge. Patients with follow-up visits within 7 days were associated with longer length of hospitalization (4 or longer – Follow-up Visits within 7 days (F/U): 39.1%; No Follow-up Visits within 7 days (No F/U): 36.1%), more hospitalizations before the index hospitalization (Mean (Standard Deviation) – F/U: 0.91 (1.36); No F/U: 0.77 (1.37)), and greater number of chronic conditions (6 or more – F/U: 30.6%; No F/U: 23.1%). Also, patients with follow-up visits within 7 days were more likely to be admitted due to diseases and disorders of circulatory system (F/U: 28.8%; No F/U: 24.7%) and respiratory system disease (F/U: 15.6%; No F/U: 11.4%) compared to those without follow-up visits within 7 days. Patients who did not receive follow-up visits within 7 days were more likely to live in a rural area (F/U: 11.7%; No F/U: 15%) and hospitalized due to diseases and disorders of musculoskeletal system and connective tissue problem (F/U: 5.4%; No F/U: 18.3%).

Figure 1 displays the cumulative incidence rate of follow-up visits within the 7-day timeframe. Within 7 days 40 percent of the patients had follow-up visits. The incidence rate of follow-up visits on the first day was 3.6 percent and gradually increased up to 7.1 percent until the seventh day. Figure 2 shows the cumulative incidence rate of follow-up visits within 7 days stratified by Medicare program. The cumulative incidence rate of follow-up visits within 7 days in Medicare FFS was 40.9 percent versus 38.7 percent in MA.

Figure 3 shows the hospital-level unadjusted rate of follow-up visits within 7 days. The average of hospital-level unadjusted rates of follow-up visits within 7 days was 39.4 percent. Hospital-level unadjusted rates of follow-up visits within 7 days range from 8 percent to 62.5 percent.

Table 2 reports unadjusted readmission rates by follow-up visit and Medicare program. The readmission rate in the follow-up visits group was 2.5 percent which is lower than the no

follow-up visits group (No F/U; 4.6 percent). Patients with follow-up visits are less likely to experience a 7-day readmission in both Medicare programs, but the difference in 7-day readmission rates between the follow-up visits group and no follow-up visit group is larger in Medicare FFS (F/U: 4.9 percent, No F/U: 2.6 percent) compared to MA (F/U: 3.7 percent, No F/U: 2.2 percent). Also, while the difference in 7-day readmission rates between Medicare FFS and MA was statistically significant in the no follow-up visit group (Medicare FFS: 4.9 percent, MA: 3.7 percent, P-value<0.001), we found no difference in the readmission rate between Medicare FFS and MA among patients with follow-up visits (Medicare FFS: 2.6 percent, MA: 2.2 percent, P-value=0.068).

When stratified by chronic conditions, the difference in readmission rates between the follow-up visit and no follow-up visit groups among patients with 2 or more chronic conditions (F/U: 5.8 percent, No F/U: 2.8 percent) was larger than those with 0-1 chronic condition (F/U: 2.7 percent, No F/U: 1.8 percent). This pattern was similar in both Medicare programs, but the difference between patients with and without follow-up visits was larger in Medicare FFS compared to MA. Comparing Medicare FFS and MA shows that while the difference in readmission rates between Medicare FFS and MA among patients with follow-up visits was statistically significant both in patients with 0-1 chronic conditions (Medicare FFS: 2.9 percent, MA: 2.3 percent, P-value=0.023) and with 2 or more chronic conditions (Medicare FFS: 6.1 percent, MA: 4.9 percent, P-value<0.001). However, we could not find such difference among patients without follow-up visits (0-1 chronic condition - Medicare FFS: 1.9 percent, MA: 1.6 percent, P-value=0.371; 2 or more chronic conditions - Medicare FFS: 2.9 percent, MA: 2.6 percent, P-value=0.287).

Stratifying the analysis by age shows similar results to the analysis stratified by the number of chronic conditions. We found the readmission rate was higher among patients with follow-up visits (age<80: 4.3, age 80 or older: 5.1) than those without follow-up visits (age<80: 2.6, age 80 or older: 2.4) in both age groups and the difference in readmission rate between Medicare FFS and MA among patients with no follow-up visit group in both patients under 80 years old (Medicare FFS: 4.6 percent, MA: 3.3 percent, P-value<0.001) and 80 years or older (Medicare FFS: 5.4 percent, MA: 4.4 percent, P-value=0.0.014).

Results of sensitivity analyses based on 14-day readmissions were qualitatively similar to the main analyses (Appendix Table 1).

DISCUSSION

This study examines the association between follow-up visits within 7 days after discharge and all-cause 7-day readmissions in Medicare FFS and MA. The main analysis shows that the 7-day readmission rate among patients with follow-up visits within 7 days was 46 percent lower than those with no follow-up visits within 7 days.

This pattern was consistent even when we stratified the analysis by Medicare program. However, the difference in 7-day readmission rate between follow-up visits group and no follow-up visit group was larger in Medicare FFS compared to MA. Considering MA beneficiaries are known to receive higher quality of care than those in Medicare FFS (Ayanian et al., 2013; Timbie et al., 2017), one possible explanation could be that MA provides better patient care or provides other care that could replace follow-up visits. Therefore, despite patients in MA not having follow-up visits, they could have lower readmission rates than Medicare FFS patients without a follow-up visit. As previous studies have shown that the readmission rate in Medicare

FFS is higher than that in MA (America's Health Insurance Plans (AHIP), 2010; Lemieux, Sennett, Wang, Mulligan, & Bumbaugh, 2012) and this study shows that there is no significant difference in readmission rate between Medicare FFS and MA among patients with follow-up visits, efforts to promote follow-up visits could reduce the difference in readmission rate between Medicare FFS and MA which could effectively reduce readmissions, especially in Medicare FFS

The stratified study findings by age and number of chronic conditions show that follow-up visits within 7 days are more associated with lower 7-day readmission rate for patients with 2 or more chronic conditions and/or older age compared to those with 0-1 chronic condition and/or relatively younger age. A follow-up visit after discharge is an opportunity to monitor and discuss patient's health status, perform medication reconciliation, and instruct patients and family caregivers for self-management, which has potential to prevent readmissions. Considering older age and greater number of chronic conditions are associated with sicker health status and require higher complexity of care with multiple medications (Brock et al., 2013; Caughey et al., 2010; Jindai, Nielson, Vorderstrasse, & Quinones, 2016; Liddy, Blazkho, & Mill, 2014; McDonald et al., 2007; Riverin, Li, Naimi, & Strumpf, 2017), having an outpatient physician follow-up visit to check their health status and care could be a more helpful and effective opportunity to prevent readmissions for patients with older age and multiple chronic conditions.

This study found that only 40 percent of discharged patients completed follow-up visits within 7 days. Furthermore, we observed substantial variation in follow-up visit rates between hospitals (ranging from 8 to 62.5 percent). These results suggest that hospital-based interventions to encourage follow-up visits within 7 days after discharge may be an effective and efficient way to reduce readmissions. Hospital administrators could look to evidence-based models such as Project RED which promotes follow-up visits and post-discharge follow-up phone calls as an

essential component could be helpful to both improve the follow-up visit rate and reduce readmissions (Jack et al., 2009; Kripalani, Theobald, Anctil, & Vasilevskis, 2014; Sharma et al., 2010). Also, while it is known that patients who were discharged from teaching and large hospitals are less likely to have a follow-up visit (Sharma et al., 2010), we have less information to explain the variation in rates of follow-up visits at the hospital-level. Further studies aiming to identify hospital characteristics related to high and low rate of follow-up visits could be helpful to improve and promote current interventions.

Our study has several limitations. First, we were not able to identify follow-up visits within 7 days if a readmission occurred first. Next, this analysis focused on data in the early years of several initiatives that CMS undertaken such as the Medicare Hospital Readmission Reduction Program, therefore may not reflect the full effect of these initiatives. Lastly, this study is based on Wisconsin data, thus the results may not be generalizable to other states. However, considering Medicare is a federal program, the study findings provide useful information to Medicare and policy-makers.

In conclusion, our study found outpatient follow-up visits within 7 days are associated with lower 7-day readmission rate in Medicare. More efforts to encourage patients to complete follow-up visits after discharge is needed due to the fact that only 40 percent of the patients had a follow-up visit within 7 days. Considering variation in the follow-up visit rates within 7 days by hospital, future research is needed to identify hospital characteristics and/or factors which could explain such variation, and further promote follow-up visits within 7 days after discharge.

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Table 1. Characteristics of Discharges by Follow-up Visits within 7 Days after Discharge, Wisconsin Health Information Organization All-Payer Claims Data, 2013-2014 (N=71,043).

	Overall	No Physician Follow-Up Visit	Physician Follow-Up Visit	P-value
N	71,043	42,434	28,609	
Medicare = Medicare Advantage (%)	27.1	27.8	26	<0.001
Age (%)				<0.001
66-69	19.6	21.1	17.3	
70-74	22.2	22.9	21.1	
75-79	20.4	19.9	21	
80-84	17.6	16.6	19.1	
85-89	11	10.5	11.7	
90+	9.3	9	9.8	
Gender = Female (%)	54.3	54.6	53.8	0.042
Residence = Rural (%)	13.7	15	11.7	<0.001
Length of Stay (%)				<0.001
0-1	15.1	15.8	14	
2-3	47.7	48.2	46.9	
4-5	20.6	19.7	21.9	
6+	16.7	16.4	17.2	
Number of Hospitalizations (mean (sd))	0.82 (1.37)	0.77 (1.37)	0.91 (1.36)	<0.001
Avg Days of Hospitalizations (mean (sd))	2.10 (4.18)	1.96 (4.07)	2.32 (4.32)	<0.001
Number of Chronic Conditions (%)				<0.001
0-1	20.3	23.4	15.7	
2-3	30.3	31.6	28.5	
4-5	23.3	21.9	25.3	
6-7	14.6	13.1	16.8	
8-9	7.7	6.6	9.3	
10+	3.9	3.4	4.5	
Principle Diagnosis for Index Hospitalization (%)				<0.001
Circulatory System	26.4	24.7	28.8	
Musculoskeletal System & Connective Tissue	13.1	18.3	5.4	
Respiratory System	13	11.4	15.6	
Digestive System	13.1	13.1	13.1	
Kidney & Urinary Tract	6.8	6.3	7.5	
Nervous System	6.3	6.5	6	
Infectious & Parasitic Diseases	6.2	5.5	7.3	
Endocrine, Nutritional, & Metabolic	2.8	2.5	3.2	

Factors Influencing Health Status	2.8	2.8	2.7	
Hepatobiliary System & Pancreas	2.5	2.6	2.4	
Skin, Subcutaneous Tissue & Breast	2.1	1.8	2.6	
Blood and Immunology	1.4	1.1	1.9	
Injuries, Poisonings, & Drug Toxicity	1	0.9	1.1	
Ear, Nose, Mouth, & Throat	0.8	0.7	0.9	
Female Reproductive System	0.4	0.5	0.2	
Male Reproductive System	0.3	0.4	0.2	
Eye	0.1	0.1	0.2	
Multiple Significant Trauma	0	0	0.1	
Others	0	0	0.1	
Unknown	0.7	0.7	0.8	
Hospital Teaching Status = Teaching (%)"	55.5	55.6	55.4	0.715
Hospital Bed Size (%)"				0.008
Fewer than 100	21.2	20.8	21.8	
100-300	47	47.4	46.5	
300 or more	31.8	31.8	31.7	
Hospital Location = Rural (%)"	14.5	13.7	15.8	<0.001
Hospital Tax Status = For-profit (%)"	0.9	1.3	0.2	<0.001
Hospital Average Length of Stay (%)"				<0.001
Q1	12.1	12.4	11.5	
Q2	19.4	18.4	20.9	
Q3	24.2	24.6	23.5	
Q4	44.3	44.5	44	
Hospital Percentage of Medicaid Inpatient Days (%)				<0.001
Q1	21.1	21.7	20.3	
Q2	20	19.2	21.2	
Q3	31.2	31	31.5	
Q4	27.7	28.1	27	
Hospital Staff Level (%)				<0.001
Q1	15.7	15.8	15.6	
Q2	19.8	19.2	20.7	
Q3	34.9	34.4	35.7	
Q4	29.6	30.7	28.1	

Note: Avg=Average

Figure 1. Cumulative Incidence Rate of Follow-up Visits within 7 Days After Hospital Discharge.

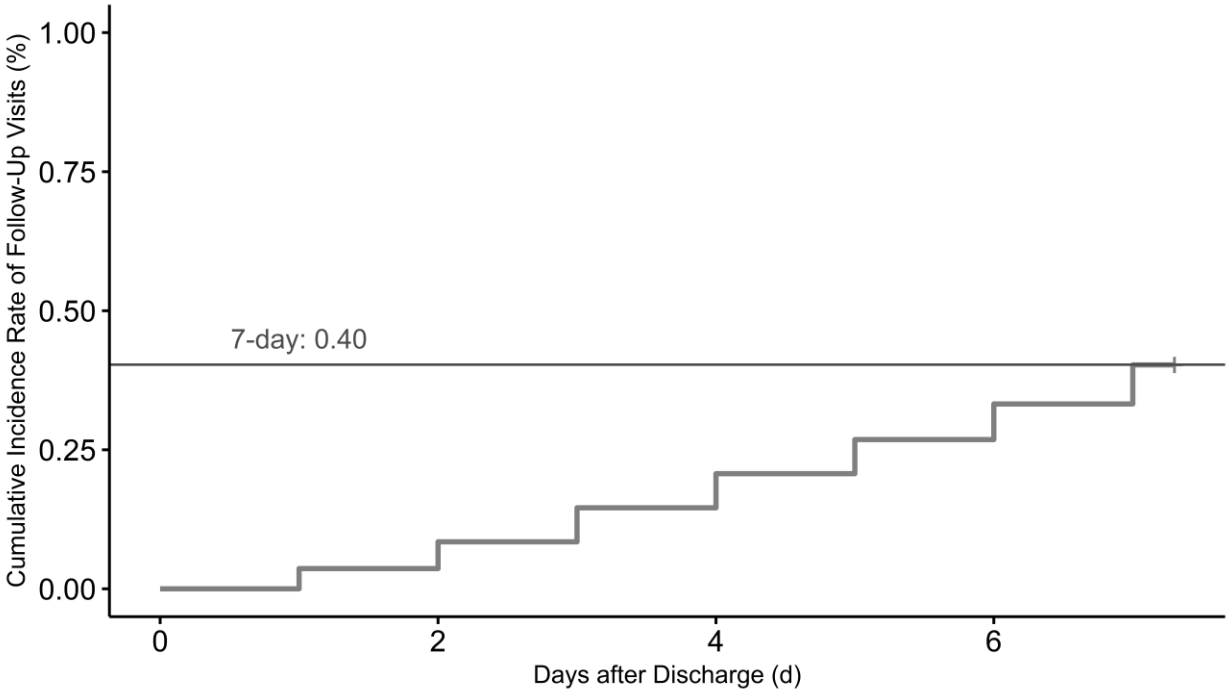
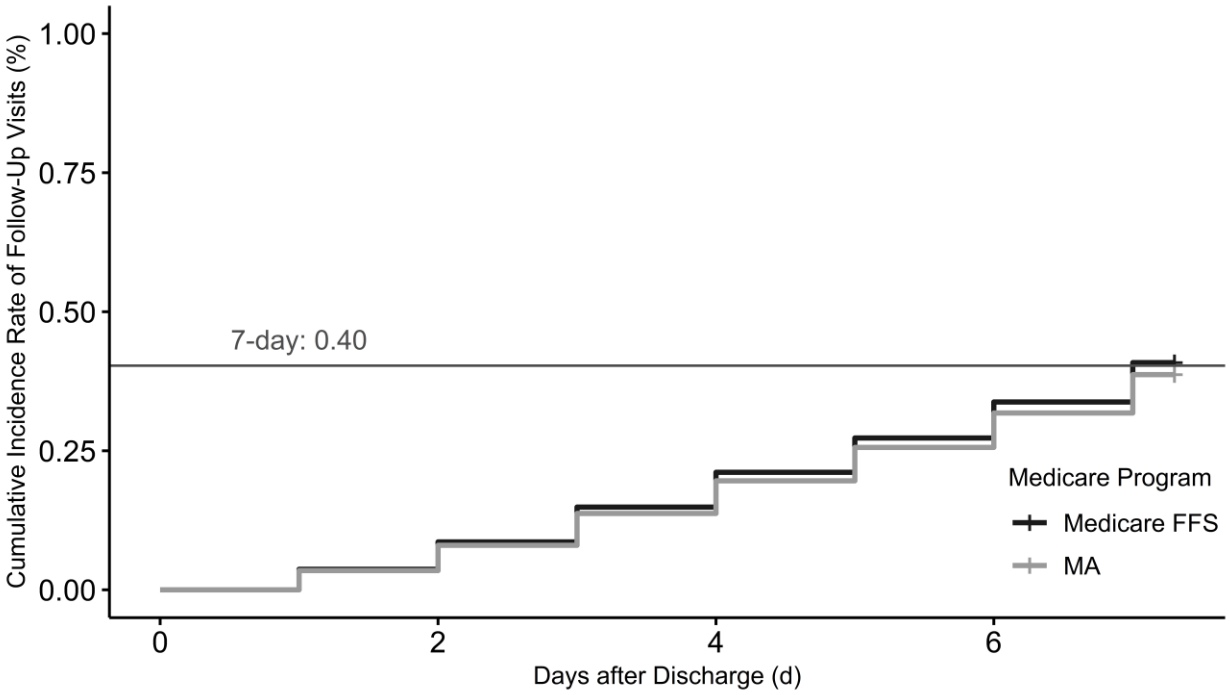
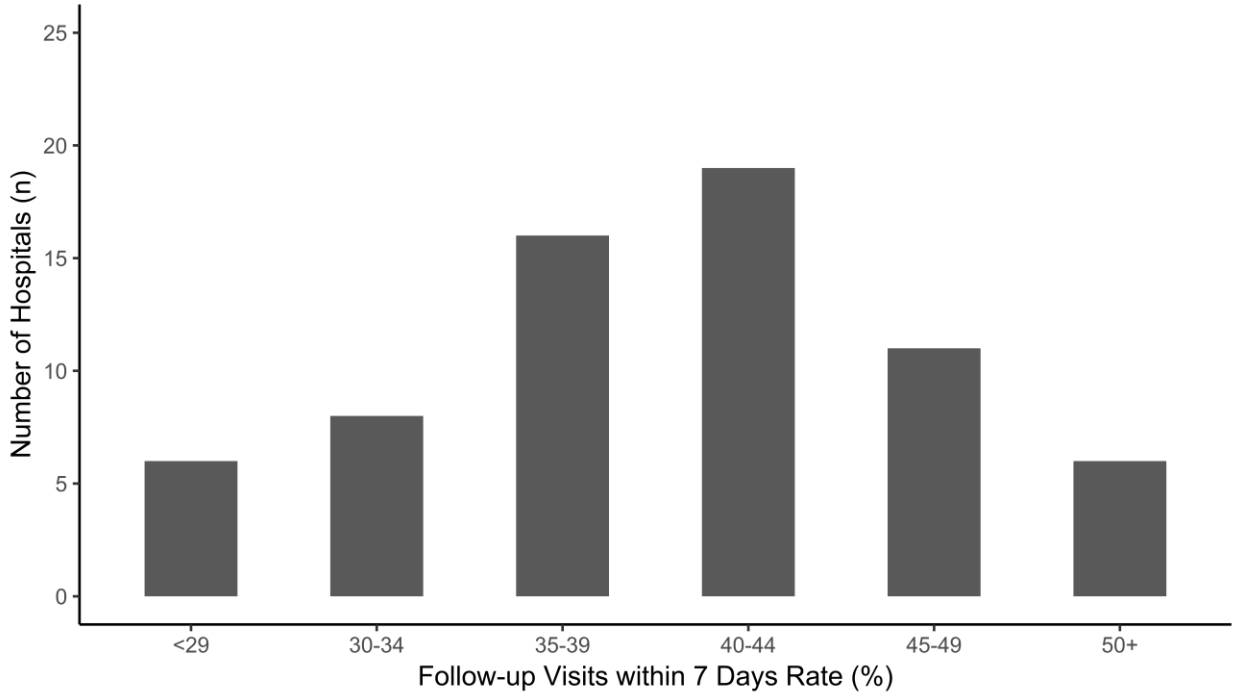


Figure 2. Cumulative Incidence Rate of Follow-up Visits within 7 Days After Hospital Discharge by Medicare Program.



Note: FFS=Fee-for-Service; MA=Medicare Advantage

Figure 3. Hospital-Level Rates of Follow-up Visits within 7 Days.



Note: Min: 8.01; Q1: 35.22; Median: 40.80; Q3: 44.56; Max: 62.47; Mean 39.35

Table 2: Unadjusted 7-day Readmission Rate by Follow-up Visits within 7 day and Medicare Program.

		Overall			Medicare Program				Medicare Program		P
					Medicare FFS		MA		Medicare FFS	MA	
		Readmission		Readmission Rate	Readmission		Readmission		Readmission Rate	Readmission Rate	
		Yes	No		Yes	No	Yes	No			
		N	N	%	N	N	N	N	%	%	
Overall	F/U	717	27892	2.5	552	20607	165	7285	2.6	2.2	0.068
	No F/U	1939	40495	4.6	1502	29129	437	11366	4.9	3.7	0.001
Chronic Condition: 0-1	F/U	150	8328	1.8	108	5682	42	2646	1.9	1.6	0.371
	No F/U	466	16562	2.7	339	11202	127	5360	2.9	2.3	0.023
Chronic Condition: 2+	F/U	567	19564	2.8	444	14925	123	4639	2.9	2.6	0.287
	No F/U	1473	23933	5.8	1163	17927	310	6006	6.1	4.9	0.001
Age:<80	F/U	437	16558	2.6	337	12130	100	4428	2.7	2.2	0.081
	No F/U	1160	25961	4.3	903	18543	257	7418	4.6	3.3	<0.001
Age: 80 or older	F/U	280	11334	2.4	215	8477	65	2857	2.5	2.2	0.49
	No F/U	779	14534	5.1	599	10586	180	3948	5.4	4.4	0.014

Note: F/U=Follow-up visits within 7 days after discharge

Appendix Table 1: Unadjusted 14-day Readmission Rate by Follow-up Visits within 7 day and Medicare Program.

		Overall			Medicare Program				Medicare Program		P
					Medicare FFS		MA		Medicare FFS	MA	
		Readmission		Readmission Rate	Readmission		Readmission		Readmission Rate	Readmission Rate	
		Yes	No		Yes	No	Yes	No			
		N	N	%	N	N	N	N	%	%	
Overall	F/U	1752	26857	6.1	1339	19820	413	7037	6.3	5.5	0.016
	No F/U	2915	39519	6.9	2229	28402	686	11117	7.3	5.8	<0.001
Chronic Condition: 0-1	F/U	334	8144	3.9	234	5556	100	2588	4	3.7	0.517
	No F/U	674	16354	4	487	11054	187	5300	4.2	3.4	0.013
Chronic Condition: 2+	F/U	1418	18713	7	1105	14264	313	4449	7.2	6.6	0.155
	No F/U	2241	23165	8.8	1742	17348	499	5817	9.1	7.9	0.003
Age:<80	F/U	1046	15949	6.2	794	11673	252	4276	6.4	5.6	0.059
	No F/U	1762	25359	6.5	1352	18094	410	7265	7	5.3	<0.001
Age: 80 or older	F/U	706	10908	6.1	545	8147	161	2761	6.3	5.5	0.149
	No F/U	1153	14160	7.5	877	10308	276	3852	7.8	6.7	0.018

Note: F/U=Follow-up visits within 7 days after discharge

Chapter 5: Discussion

5.1 Summary of Results

This dissertation describes potential opportunities to reduce hospital readmissions in Medicare. This research identified that the all-cause 30-day readmission rate was higher among patients in Medicare Fee-for-Service (FFS) compare to those in Medicare Advantage (MA) for patients using the same hospital. This pattern was also found with 3- and 7-day readmissions which may more directly reflect associations with inpatient care and transitional care. Also, this research demonstrates that the association between Medicare programs and readmission varies by patients' health status defined by patients' number of chronic conditions. The mean predicted probabilities of readmission in Medicare FFS were 16-18 percent higher than MA among those with 0-1 or 2-3 chronic conditions, while we found no difference in the mean predicted probability of readmissions between Medicare FFS and MA among those with greater number of chronic conditions. Finally, this research shows that follow-up visits within 7 days after discharge are associated with 7-day readmissions in Medicare.

5.2 Implications

The findings of this dissertation have several implications. Higher readmission rate in Medicare FFS compared with MA within in the same hospital suggest we need to pay attention on not only improving care related to readmissions but also ensuring all patients are receiving the same quality of care regardless of payer. One possible suggestion is improving current

monitoring systems for hospitals by including payer-specific data. Since 2009, CMS is publicly reporting the hospital all-cause 30-day readmission rates only for Medicare FFS patients. Reporting payer-specific readmission rates by hospitals could encourage providers and hospitals to not only improve the care to reduce readmissions but to also consider reducing the gap in care by payer. Also, it could increase the transparency of hospital care and help consumers in choosing care venues.

Moreover, the study findings suggest that comparing overall readmission rates provides limited information for understanding differences between FFS and MA, and stratified information related to readmissions could be helpful in target services. The results show larger relative differences in readmission rates between Medicare FFS and MA among patients with 0-1 and 2-3 chronic conditions compared to those with greater numbers of chronic conditions. We need to improve our understanding of the difference between Medicare FFS and MA by patients' health status, which could identify opportunities to efficiently improve patients' health and reduce readmissions in each Medicare program. Also, information related to readmissions stratified by patients' number of chronic conditions could deliver useful evidence to policy-makers to modify and develop programs that could achieve further quality of care improvement and readmissions reduction in Medicare. For example, despite several interventions and models to improve transitional care and care coordination are known to be effective in reducing readmissions (Borza et al., 2018; Hansen et al., 2013; Hansen, Young, Hinami, Leung, & Williams, 2011), we have less information on how the effect of these interventions varies by patient's health status which represents the severity of illness and, often, the complexity of care. Improving our understanding could help us identify opportunities to facilitate hospital

readmission reduction based on how to apply and develop interventions to improve care, and whether we need further attention on specific target groups.

The study also provides evidence on the need to promote follow-up visits within 7 days to reduce readmission rates in Medicare, as the results show that only 40 percent of discharged patients completed follow-up visits within 7 days. More efforts to schedule follow-up visits after discharge and to conduct phone calls after discharge to encourage patients to complete follow-up visits could be helpful to reduce readmissions. Also, considering that follow-up visit rates at the hospital-level within 7 days show a large variation from 8 to 62.5 percent, efforts to encourage follow-up visits within 7 days after discharge based on hospital-based interventions could be an effective and efficient way to reduce readmissions. Hospital-based interventions such as Project RED which promotes follow-up visits and post-discharge follow-up phone calls as an essential component could be helpful to both improve the follow-up visit rates and reduce readmissions (Kripalani, Theobald, Anctil, & Vasilevskis, 2014; Sharma, Kuo, Freeman, Zhang, & Goodwin, 2010).

5.3 Directions for Future Research

The findings from this dissertation suggest several possible extensions. First, to our knowledge, there is no study that directly examines whether the quality of inpatient care and transitional care varies between Medicare FFS and MA. Further studies need to examine the difference in inpatient and transitional care by using measures such as patient safety indicators to provide a deeper understanding of opportunities to reduce readmissions in Medicare.

Additional studies to identify factors and healthcare services that lead to differences in care related to readmissions by Medicare programs will also be helpful for policy makers to develop strategies and incentives that influence hospitals, providers, and patients. The current study has examined potential patient-, hospital-, and outpatient-level factors that could explain readmission rate differences between Medicare FFS and MA to provide evidence on possibilities to reduce readmission rates in Medicare. However, there should be more research to examine other factors related to readmission rate differences by Medicare program. For example, while the present study suggests differences in quality of care between patients in Medicare FFS and MA even for patients using the same hospital, more studies on external factors that could explain differences in readmission rates by Medicare program would be valuable. Previous studies have found that factors such as lack of social support, living situation, and community and neighborhood factors are associated with the risk of readmission. These could be considered as non-medical factors outside of hospitals' control (Calvillo–King et al., 2013; Herrin et al., 2015; Kind et al., 2014). However, we have limited understanding of whether and how these external factors vary between patients in Medicare FFS and MA, and whether variation in external factors is associated with readmission rate differences. Improving our understanding of factors to explain readmission rate differences by Medicare program is important to identify and prioritize possible factors that could lead to readmissions reduction in each Medicare program.

The dissertation has also found that hospitals' readmission rates in MA were lower than those of Medicare FFS within the same hospital. However, there were some variations in the strength of difference between FFS and MA across hospitals. This study did not find specific

hospital characteristics (including teaching status, tax status, hospital geographic location, and hospital size) associated to the variations in readmission rate differences between FFS and MA among hospitals. However, more efforts to identify hospital characteristics could explain the variations and further benefit development and improvement of interventions to efficiently enhance care and reduce readmissions.

Moreover, we have less information explaining the variations in hospital-level rate of follow-up visits. There is limited and mixed information regarding the association between hospital characteristics and follow-up visits. While Sharma et al.(2010) found that patients discharged from nonteaching, for-profit, and smaller sized hospitals were more likely to have a follow-up visit, Fontanella et al. (2016) found that patients treated from a teaching hospital were associated with a higher likelihood of a follow-up visit. In the present study, the hospital-level rates of follow-up visit within 7 days after discharge range from 8 percent to 62.5 percent among 66 hospitals. Further studies aiming to identify hospital characteristics related to high and low hospital-level rates of follow-up visit could help improve and promote current interventions.

Several interventions for improving transitional care and care coordination, and models such as accountable care organizations are known to be effective in reducing rehospitalizations (Borza et al., 2018; Hansen et al., 2013, 2011). While past studies have focused on specific health conditions such as acute myocardial infarction and heart failure (Rabbat et al., 2012; Ziaeian & Fonarow, 2016), however, we have less information on how the effects of these interventions varies by patient's health status which represents the severity of illness and complexity of care. Improving our understanding could help us identify ways to facilitate

hospital readmission reduction by applying and developing interventions to improve care, and identifying whether we need further attention according to some targeted group.

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