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Hospital Readmissions Reduction Program and Post-Acute Care: Implications for Service Delivery and 30-day Hospital Readmission

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Abstract

Objectives: Examine whether the introduction of the Hospital Readmissions Reduction Program (HRRP) is associated with changes in post-acute care (PAC) use and 30-day readmission.

Design: A retrospective cohort study examined data pre-passage, pre-implementation, and post-implementation of the HRRP.

Setting and Participants: 7,851,430 Medicare beneficiaries discharged from 5,116 acute hospitals to PAC settings including inpatient rehabilitation, skilled nursing, home health, or a long-term care hospital during 2007–2015. We examined both HRRP targeted conditions (acute myocardial infarction, heart failure and pneumonia) and non-targeted conditions (ischemic stroke, total hip arthroplasty/total knee arthroplasty [THA/TKA] and hip/femur fractures).

Measures: The hospital-level of quarterly PAC use and the association with 30-day risk-standardized readmission rates. Outcomes were calculated for HRRP targeted and non-targeted conditions/diagnoses across three phases of HRRP implementation.

Results: An increase in quarterly PAC use was significantly ($p < .001$) associated with a decrease in 30-day risk-standardized readmission rates for acute myocardial infarction, heart failure and

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Conflicts of Interest:

All authors declare that they had no conflicts of interest in any regard with respect to publishing this paper.

hip/femur fracture. In contrast, an increase in quarterly PAC use was significantly associated with an increase in readmission rate for THA/TKA ($p<.001$). PAC quarterly use and readmission rates varied significantly during implementation periods for HRRP targeted and non-targeted conditions.

Conclusions and Implications: The impact on readmission after PAC for selected impairment groups may be mediated by the type of PAC services received and whether the diagnoses is included in the HRRP. Additional research is necessary to determine if a reduction in readmission is associated with inclusion in the HRRP or is a side effect related to diagnostic group and/or type of PAC services received.

Brief Summary:

To examine the effect of Hospital Readmissions Reduction Program (HRRP) on the use of post-acute care services and hospital readmission with 7,851,430 Fee-For-Service Medicare beneficiaries discharged from 5,116 hospitals over three HRRP periods.

Keywords

Subacute Care; Patient Readmission; Hospital Readmissions Reduction Program

INTRODUCTION

The Hospital Readmissions Reduction Program (HRRP) is a value-based program that adjusts Medicare payment for hospitals that do not meet a benchmark readmission rate determined by the Centers for Medicare and Medicaid Services (CMS)¹. The intervention components of the HRRP are 30-day readmission rates based on three previous years of data¹. The CMS¹⁻³, Kaiser Foundation⁴, Berenson et al.⁵, Zuckerman et al.⁶ and others⁷⁻¹⁰ have reported lower readmission rates after the passage and implementation of the Hospital Readmissions Reduction Program (HRRP). The HRRP was included in the Patient Protection and Affordable Care Act^{2,11}. Originally, the HRRP included myocardial infarction, heart failure and pneumonia. The reduction in hospital readmission rates suggests improvement in discharge planning and care transitions^{3,4}. Coordinating and expanding care beyond the acute hospital is an important part of healthcare reform^{6,12-13}. The influence of structural changes in discharge planning, care transitions and post-discharge outcomes is reflected in the expanding focus on post-acute care (PAC).

Discharge to PAC settings -- including home health agencies, skilled nursing facilities, inpatient rehabilitation facilities and long-term care hospitals -- increased nearly 50% over the past 15 years¹⁴⁻¹⁵. The National Academy of Sciences found that PAC services are responsible for the largest geographic variation in Medicare spending¹⁶. The increased focus, use and cost associated with PAC services led to passage of the Improving Medicare Post-Acute Care Transformation Act in 2014¹⁷⁻²⁰.

The purpose of our study was to examine the relationship between HRRP and PAC use, and answer the following questions: 1) Was the introduction of HRRP associated with changes in PAC use? 2) Are there differences in readmission rates across PAC settings for patients originally included in the HRRP (acute myocardial infarction, heart failure and pneumonia)?

And 3) Are there different outcomes for HRRP based on PAC use in conditions originally targeted by HRRP (see #2) and non-targeted conditions such as ischemic stroke, knee/hip arthroplasty and hip/femur fractures? These are diagnoses commonly discharged to PAC settings, but not originally targeted by HRRP.

We examined PAC use and hospital readmission rate changes for HRRP involving both targeted and non-targeted conditions over eight-years. Based on a Medicare Payment Advisory Commission⁶ report that found a reduction in readmission rates for non-targeted conditions, we hypothesized that the HRRP is related to PAC use. Over time, there may be a spillover effect from the HRRP involving reduced hospital readmission for both targeted and non-targeted conditions/diagnoses.

METHODS

Data Source

We used 100% Medicare claims data between January 2007 and August 2015. These included Medicare Beneficiary Summary files that provided patient demographics and enrollment information, and Medicare Provider Analysis and Review (MedPAR) files for inpatient claims. The study timeframe covered three periods: pre-HRRP (period A: January 2007 – March 2010); post-HRRP passage but before HRRP implementation (period B: April 2010 – December 2011); and post-HRRP implementation (period C: January 2013 – August 2015) (Figure 1). We selected three periods (pre-passage, pre-implementation and post-implementation) because we assumed care settings might respond differently in these three stages of the HRRP (Figure 1). Additionally, the three periods are consistent with published articles^{6,8} and allow comparisons of our finding with previous studies. The study was reviewed by the university Institutional Review Board and a Data Use Agreements was obtained from CMS. We did not have access to Medicare Data for 2012. The absence of 2012 data is referred to in the Results and explained in the Discussion.

Study Samples

From MedPAR files, we first selected hospital discharges for a condition or diagnosis of interest based on the Medicare Severity-Diagnosis Related Group, including the original three HRRP conditions: acute myocardial infarction (280–282); heart failure (291–293); pneumonia (193–195). We also included three conditions that were originally not included in the HRRP. The non-HRRP conditions included stroke (61–66), total hip arthroplasty/total knee arthroplasty (TKA/THA; 469–470) and hip/femur fractures procedures (480–482, 533–536)^{21–22}.

We followed the inclusion/exclusion criteria described in the CMS reports on condition- and procedure-specific hospital-level 30-day risk-standardized readmission measures^{21–22} to identify the sample. The sample included persons aged 66–100 years at admission, with continuous Medicare Part A coverage, not enrolled in managed care in the year before admission and the 30 days after discharge, who survived 30 days post discharge and whose admission was elective, urgent or for emergency.

Patients were excluded if discharged against medical advice, admitted for the same condition/procedure in the prior 30 days or transferred to another hospital. We included only patients admitted to acute hospitals from the community. For patients with more than one discharge in a quarter, only the first discharge was included (see Appendix Table 1).

For acute myocardial infarction, patients admitted and discharged on the same day were excluded. For heart failure, patients with left ventricular assist device implantation or a heart transplant during the index admission or in the prior year were excluded. For stroke, only patients with ischemic stroke were included. For THA/TKA, only patients with elective total hip or knee arthroplasty were included. Our analyzed data were from January 2007 to August 2015, which was before HRRP changed to include THA/TKA (2015 October). We recognize there could be an overlapping transition period when providers responded to the new implementation of THA/TKA in HRRP. However, for consistency of interpretation, this study considered THA/TKA a non-HRRP targeted condition.

Study Measures

Primary Outcome—The primary outcome was hospital discharge to PAC by quarter during 2007–2015 (except 2012). Using the discharge destination code on the MedPAR claim of the index admission, we defined PAC discharge as one to an inpatient rehabilitation facility, skilled nursing facility, home health agency or long-term care hospital⁶. We calculated the hospital-level PAC use rate quarterly for each targeted and non-targeted condition.

Secondary Outcome—The secondary outcome was the 30-day risk-standardized readmission rate for each hospital at each quarter following the methodology used in the CMS reports^{21–22}. Hierarchical logistic regression models were built using age, sex, condition-/procedure-specific risk variables and a hospital-specific effect, to estimate the “predicted” number of readmissions for each hospital, and account for the clustering of patients within hospitals. The “expected” number of readmissions for each hospital without the hospital-specific effect (random effect) was then estimated. The 30-day risk-standardized readmission rate was calculated as the ratio of the “predicted” to “expected” number of readmissions, multiplied by the overall observed readmission rate for a given quarter for a given condition/procedure for a particular hospital.

Risk Adjustment Variables—We used the CMS reports^{21–22} to identify required risk adjustment variables for each condition. Age and sex were obtained from the Beneficiary Summary files. The diagnoses from MedPAR claims in the prior year and the secondary diagnoses during the index admission were used to identify comorbidities. Comorbidity was captured using CMS condition categories for each specific condition/procedure. The crosswalks between CMS condition categories and International Classification of Diseases 9th revision, Clinical Modification (ICD-9-CM) codes can be found on [QualityNet.org](https://www.qualitynet.org)²³.

Statistical Analysis

For each period, we calculated the mean, standard deviation, median and interquartile range for the quarterly hospital-level PAC use and risk-standardized readmission rates. We

examined the effect of PAC use in each HRRP period by including an interaction term between the quarterly PAC use and the HRRP period indicator in the model. We also performed longitudinal data analyses by using a linear mixed effect model with a hospital-specific random effect and Autoregressive (AR1) covariance structure to examine the impact of PAC use on 30-day risk-standardized readmission rates. All calculations were conducted separately for each impairment condition with SAS 9.4 software (SAS Institute, Inc., Cary, NC) to perform all analyses.

RESULTS

The introduction of HRRP was marginally associated with changes in PAC use.

Table 1 shows the overall impact of quarterly PAC use on 30-day risk-standardized readmission rates regardless of HRRP period, for both targeted and non-targeted conditions. PAC use was a significant predictor for 30-day risk-standardized readmission in four conditions: acute myocardial infarction, heart failure, THA/TKA and hip/femur fracture; but not for pneumonia or ischemic stroke (see Table 1).

Acute myocardial infarction was the condition with the largest effect size of PAC use on readmission rates (-0.0120 [95% confidence interval {CI}: -0.0129 , -0.0111]) while pneumonia had the least (0.00001 [95% CI: -0.0001 , 0.0002]) (Table 1). An increase in quarterly PAC use was significantly associated with a decrease in 30-day risk-standardized readmission rates for acute myocardial infarction, heart failure and hip/femur fracture (all $p < 0.001$). In contrast, an increase in quarterly PAC use was significantly associated with an increase in the 30-day risk-standardized readmission rate for THA/TKA ($p < 0.001$) (Table 1).

Reduced readmission rates were found across PAC settings for patients originally included in the HRRP.

Table 2 shows the detailed trends and effect of PAC use on 30-day risk-adjusted readmission rates across three HRRP periods for three targeted conditions. Across three HRRP periods, all three HRRP targeted conditions (acute myocardial infarction, heart failure and pneumonia) showed reduced 30-day risk adjusted readmission rates across PAC settings (all $p < 0.0001$) (Table 2).

There were different impacts of HRRP on PAC use between the conditions originally targeted by HRRP and the others not originally targeted by HRRP.

PAC Use and Readmission Trends for Three Periods: Targeted Conditions.—

As hypothesized, PAC use increased for all three targeted conditions over three HRRP periods (Table 2). However, the increase of PAC use varied by period and by condition. For acute myocardial infarction, PAC use increased from periods A to B ($p=0.007$), then remained stable during period C. For heart failure, PAC use increased in all three periods (both $p < 0.001$). For pneumonia, PAC use did not increase until period C ($p=0.03$) (Table 2). The effect of PAC use on 30-day risk-standardized readmission rates varied significantly by period for acute myocardial infarction (from -0.0164 to 0.0120 , $p < 0.001$ for periods A vs. B) and for pneumonia (from 0.0002 to -0.0003 , $p=0.02$ for periods B vs. C); the effect

varied marginally for heart failure (from 0.0001 to -0.0004 , $p=0.05$ for periods A vs. B) (Table 2).

PAC Use and Readmission Trends for Three Periods: Non-Targeted

Conditions.—Table 3 shows the detailed trends and effect of PAC use on 30-day risk-standardized readmission rates across three HRRP periods for three non-targeted conditions. An increase in PAC use was associated with decreased readmission rates for all non-targeted conditions only from periods A to B. For ischemic stroke, PAC use did not significantly increase from periods A to B and did not significantly change from periods B to C. For THA/TKA, PAC use did not significantly increase from periods A to B, but it dropped significantly from periods B to C ($p<0.001$). For hip/femur fracture, PAC use significantly increased from periods A to B ($p<0.001$) and significantly decreased from periods B to C ($p=0.02$). The effect of PAC use on 30-day risk-standardized readmission rates varied significantly by period only for hip/femur fracture (from -0.0018 to -0.0010 , $p<0.001$ for periods B-C) (Table 3).

DISCUSSION

Our findings provide evidence that the introduction of the HRRP is associated with changes in PAC use. We found PAC use is significantly associated with changes in 30-day hospital readmission rates for acute myocardial infarction, heart failure, THA/TKA and hip/femur fractures over three HRRP periods associated with implementation. We found different outcomes across the HRRP periods for PAC use among the conditions originally targeted by the HRRP and the non-targeted conditions. As hypothesized, we also found a spillover effect of HRRP for 30-day readmission rates involving patients with non-targeted conditions.

For orthopedic conditions (THA/TKA), an increase was found in PAC use and readmission rates before and after HRRP implementation. This finding could be due to systematic adaptations that occurred prior to 2015. THA/TKAs were added to the HRRP in 2015 (period C). It is unclear how these pre-adaptations might have contributed to changes in PAC use in THA/TKA. This is a potential topic for future study.

To identify whether HRRP was related to changes in off-hospital services such as community-based resources and programs is important. Our finding suggest the positive effect of HRRP in reducing readmission rates could be applied not only to the acute hospital but also to PAC settings. We recommend future studies explore a wide range of factors (e.g., social determinants, profit status) that may mediate PAC use and readmission rates²⁴. The current HRRP regulatory program has a narrow scope^{25–26}. Research has demonstrated that follow-up and ancillary care beyond the hospital is crucial in reducing readmissions^{3,27–28}. Expanded research will help us understand the short- and long-term benefits of HRRP in PAC settings.

Our study is the first we are aware of to examine the effect of HRRP on PAC use across HRRP-targeted and non-targeted diagnoses. Our findings should provide useful information for stakeholders in healthcare systems to improve care transitions involving patients, caregivers, practitioners, administrators and policy makers. PAC settings and services are

developing more partnerships with healthcare systems and expanding health networks. This integration is consistent with the change in payment models, such as bundled payment, that include extended episodes of care and national quality measures. Our findings highlight the potential importance of the connection between PAC use and readmission during the implementation of HRRP. The value of better understanding the HRRP in relation to PAC services is important as we integrate quality measures and other components across acute and post-acute care environments²⁹.

Study Limitations

No risk-adjusted readmission model specific to hip/femur fractures was available from CMS for the period of the study and we used the elective THA/TKA model instead. We are aware that using this (substitute) model may not accurately reflect the estimated readmission risks for the hip or femur fracture populations. Our analyses were restricted to hospital-level characteristics available in Medicare data. We were not able to include characteristics such as social determinants in the analyses of readmission risk^{27–28}. Our study did not account for different value-based payment models or other reimbursement policies that could affect the spillover of PAC use and 30-day readmission. We selected only beneficiaries with fee-for-service coverage and our results are not generalizable to persons with different insurance coverage, such as Medicare Advantage, Health Maintenance Organization plans or Accountable Care Organizations. Finally, as noted previously, we did have access to Medicare data from 2012. This could have impacted our findings in unknown ways. We are not aware of any unique or unusual events for 2012 that would have influenced our data or findings in a negative way.

CONCLUSIONS AND IMPLICATIONS

Our findings suggest that the introduction of the HRRP was associated with changes in PAC use and reduced readmission in selected impairment groups. The influence on 30-day risk-standardized hospital readmission rates after receiving PAC services may be mediated by the type of services received and the inclusion of the diagnoses/conditions in the HRRP.

We found trends in rates of hospital-level quarterly use statistics and hospital readmission rates for three non-targeted conditions (ischemic stroke, THA/TKA and hip/femur fracture). These trends varied across the three periods of HRRP exposure (pre-passage of HRRP, from passage to implementation and following implementation). Our findings reflect the complex interactions between acute and post-acute care and highlight the need for research to develop quality measures and protocols for discharge planning, treatment and prevention required by recent legislation related to value-based purchasing and care¹⁷.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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ABBREVIATIONS

CMS	Centers for Medicare and Medicaid Services
HRRP	Hospital Readmissions Reduction Program
MedPAR	Medicare Provider Analysis and Review
PAC	Post-Acute Care
THA/TKA	Total Hip Arthroplasty/Total Knee Arthroplasty

REFERENCES

- Centers for Medicare and Medicaid Services. Hospital Readmissions Reduction Program (HRRP). Available at: <https://www.cms.gov/medicare/medicare-fee-for-service-payment/acuteinpatientpps/readmissions-reduction-program.html> Accessed January 5, 2018.
- Medicare Payment Advisory Commission. Report to the Congress: "Chapter 1: mandated report: the effects of the Hospital Readmissions Reduction Program". Available at: http://www.medpac.gov/docs/default-source/reports/jun18_ch1_medpacreport_sec.pdf?sfvrsn=0 Accessed July 13, 2018
- U.S. Department of Health and Human Services. New HHS data shows major strides made in patient safety, leading to improved care and savings. Available at: <http://innovation.cms.gov/Files/reports/patient-safety-results.pdf> Accessed January 21, 2016.
- Henry J Kaiser Family Foundation. Aiming for fewer hospital U-turns: the Medicare Hospital Readmission Reduction Program. Available at: <https://www.kff.org/medicare/issue-brief/aiming-for-fewer-hospital-u-turns-the-medicare-hospital-readmission-reduction-program/> Accessed October 5, 2018.
- Berenson RA, Paulus RA, Kalman NS. Medicare's readmissions reduction program - a positive alternative. *N Engl J Med*. 2012;366:1364–6. doi:10.1056/NEJMp1201268. [PubMed: 22455754]
- Zuckerman RB, Sheingold SH, Orav EJ, Ruhter J, et al. Readmissions, observation, and the Hospital Readmissions Reduction Program. *N Engl J Med*. 2016;374: 1543–51. doi:10.1056/NEJMsa1513024. [PubMed: 26910198]
- Birmingham LE, Oglesby WH. Readmission rates in not-for-profit vs. proprietary hospitals before and after the Hospital Readmission Reduction Program implementation. *BMC Health Serv Res*. 2018;18(1): 31. doi: 10.1186/s12913-018-2840-4. [PubMed: 29351776]
- Gerhardt G, Yemane A, Hickman P, Oelschlaeger A, et al. Medicare readmission rates showed meaningful decline in 2012. *Medicare Medicaid Res Rev*. 2013;28: 3(2). pii: mmrr.003.02.b01. doi: 10.5600/mmrr.003.02.b01. eCollection 2013.
- Ibrahim AM, Dimick JB, Sinha SS, Hollingsworth JM, et al. Association of coded severity with readmission reduction after the Hospital Readmissions Reduction Program. *JAMA Intern Med*. 2018;1: 178(2):290–292. doi: 10.1001/jamainternmed.2017.6148. [PubMed: 29131896]

10. Wasfy JH, Zigler CM, Choirat C, Wang Y, et al. Readmission rates after passage of the Hospital Readmissions Reduction Program: a pre-post analysis. *Ann Intern Med.* 2017;7: 166(5):324–331. doi: 10.7326/M16-0185. [PubMed: 28024302]
11. US Congress. Patient Protection and Affordable Care Act. Public law 111–148 published on March 23, 2010. <https://www.govinfo.gov/app/details/PLAW111publ148/PLAW-111publ148>. Accessed April 6, 2020.
12. Hernandez AF, Greiner MA, Fonarow GC, et al. Relationship between early physician follow-up and 30-day readmission among Medicare beneficiaries hospitalized for heart failure. *JAMA.* 2010;5: 303(17):1716–22. doi: 10.1001/jama.2010.533. [PubMed: 20442387]
13. Joynt KE, Figueroa JE, Oray J, et al. Opinions on the Hospital Readmission Reduction Program: Results of a national survey of hospital leaders. *Am J Manag Care.* 2016;1: 22(8):e287–94. [PubMed: 27556831]
14. Medicare Payment Advisory Commission. 6 2016 Report to the congress: Medicare and the health care delivery system. Available at: <http://www.medpac.gov/docs/default-source/reports/june-2016-report-to-the-congress-medicare-and-the-health-care-delivery-system.pdf?sfvrsn=0>. Accessed September 3, 2017.
15. Medicare Payment Advisory Commission. 3 2015 Report to the Congress: Medicare’s post-acute care: Trends and ways to rationalize payments. Available at: <http://www.medpac.gov/docs/default-source/reports/chapter-7-medicare-s-post-acute-care-trends-and-ways-to-rationalize-payments-march-2015-report-.pdf>. Accessed February 21, 2020.
16. Institute of Medicine: National Academy of Sciences, Engineering, Medicine. Variation in Health Care Spending: Target Decision Making, Not Geography. Washington, DC: 2013: 23–124.
17. Center for Medicare and Medicaid Services. Medicare Learning Network Connect. Implementing the IMPACT Act: 2017 Status Update & Activities. Available at: <https://www.cms.gov/Outreach-and-Education/Outreach/NPC/Downloads/2017-02-23-IMPACT-Presentation.pdf> Accessed June 25, 2018.
18. Centers for Medicare and Medicaid Services. Bundled payments for care improvement (BPCI) initiative: general information. Available at: <http://innovation.cms.gov/initiatives/bundled-payments/>. Accessed April 5, 2018.
19. Chen LM, Meara E, Birkmeyer JD. Medicare’s Bundled Payments for Care Improvement (BPCI) Initiative: expanding enrollment suggests potential for large impact. *Am J Manag Care.* 2015; 21(11): 814–820. [PubMed: 26633254]
20. Huckfeldt PJ, Mehrotra A, Hussey PS. The relative importance of post-acute care and readmissions for post-discharge spending. *Health Serv Res.* 2016; 51(5):1919–38. doi: 10.1111/1475-6773.12448. [PubMed: 26841171]
21. Centers for Medicare and Medicaid Services. 2016 Condition-specific measures updates and specifications report hospital-level 30-day risk-standardized readmission measures. Available at: http://aann.org/uploads/Condition_Specific_Readmission_Measures.pdf Accessed May 3, 2017.
22. The Centers for Medicare and Medicaid Services. 2016 Procedure-specific measures updates and specifications report hospital-level 30-day risk-standardized readmission measures. Available at: http://aann.org/uploads/Condition_Specific_Readmission_Measures.pdf Accessed May 3, 2017.
23. Quality Net. Condition Category/ICD-9-CM/ICD-10-CM Crosswalks. Available at: <https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPPage%2FQnetTier4&cid=1219069856694>. Accessed on 7/31/2017.
24. Li CY, Karmarkar A, Lin YL, Kuo YF, Ottenbacher KJ, Graham JE. Is profit status of Inpatient Rehabilitation Facilities independently associated with 30-day unplanned hospital readmission for Medicare beneficiaries? *Arch Phys Med Rehabil.* 2018; 99(3):598–602.e2. doi: 10.1016/j.apmr.2017.09.002. [PubMed: 28958606]
25. Dizon ML, Reinking C. Reducing readmissions: nurse-driven interventions in the transition of care from the hospital. *Worldviews Evid Based Nurs.* 2017; 14(6):432–439. doi: 10.1111/wvn.12260. [PubMed: 29024460]
26. Gerhardt G, Yemane A, Apostle K, Oelschlaeger A, et al. Evaluating whether changes in utilization of hospital outpatient services contributed to lower Medicare readmission rate. *Medicare Medicaid Res Rev.* 2014; 4(1). doi: 10.5600/mmrr2014-004-01-b03. eCollection 2014.

27. National Quality Forum. Risk adjustment for socioeconomic status or other sociodemographic factors. 7 2 2014 Technical Report. Available at: http://www.qualityforum.org/Projects/nr/Risk_Adjustment_and_Socioeconomic_Status/Draft_Report_for_CSAC_Review.aspx. Accessed March 27, 2015.
28. Nguyen CA, Gilstrap LG, Chernew ME, McWilliams JM, et al. Social risk adjustment of quality measures for diabetes and cardiovascular disease in a commercially insured US population. JAMA Netw Open. 2019;1;2(3):e190838. doi: 10.1001/jamanetworkopen.2019.0838. [PubMed: 30924891]
29. US Congress. Improving Medicare Post-Acute Care Transformation (IMPACT) Act of 2014. Public law 113–185 published on October 6, 2014. Retrieved 4/6/2020 from <https://www.congress.gov/113/plaws/publ185/PLAW-113publ185.pdf>

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Figure 1. Timeline of policies and study cohort relevant to Hospital Readmissions Reduction Program.

Figure 1 demonstrates timeline of policies and three period (A, B and C) relevant to Hospital Readmissions Reduction Program in the study.

Abbreviations: HRRP: Hospital Readmissions Reduction Program. THA/TKA: Total Hip Arthroplasty/Total Knee Arthroplasty.

Table 1.

Estimated Overall Effect of PAC Use on 30-Day Risk-Standardized Readmission.

Condition	PAC Utilization (%) Mean ± STD, Median (Q1–Q3)	RSRR (%) Mean ± STD, Median (Q1–Q3)	Effect of PAC Use on RSRR	p value
HRRP-targeted Condition				
Acute Myocardial Infarction	31.0 ± 18.4, 32.3 (20.0–42.0)	26.8 ± 2.4, 26.8 (25.3–28.2)	–0.0120 (–0.0129, –0.0111)	<0.001
Heart Failure	34.1 ± 18.0, 36.0 (21.5–46.4)	21.7 ± 0.4, 21.7 (21.5–21.8)	–0.0003 (–0.0004, –0.0001)	0.001
Pneumonia	32.6 ± 17.1, 34.4 (20.6–43.9)	15.1 ± 0.2, 15.1 (15.0–15.2)	0.0000 (–0.0001, 0.0002)	0.78
HRRP-non-targeted Condition				
Ischemic Stroke	52.6 ± 24.0, 60.5 (39.6–68.8)	12.6 ± 0.4, 12.6 (12.5–12.8)	0.0001 (–0.0001, 0.0002)	0.08
THA/TKA	68.9 ± 29.8, 80.5 (50.0–93.7)	5.1 ± 0.3, 5.1 (5.0–5.1)	0.0001 (0.0001, 0.0002)	<0.001
Hip/Femur Fracture	70.6 ± 34.2, 89.0 (52.6–94.8)	12.7 ± 0.6, 12.7 (12.5–12.9)	–0.0013 (–0.0015, –0.0011)	<0.001

PAC: post-acute care; STD: standard deviation; HRRP: Hospital Readmissions Reduction Program. THA/TKA: Total Hip Arthroplasty/ Total Knee Arthroplasty.

Table 2.

Descriptive PAC Use (%), 30-Day Risk-Standardized Readmission (%) and the Estimated Effect of PAC Use on 30-Day Risk-Standardized Readmission by Period: **HRRP-Targeted Conditions**.

Condition	Pre-passage (A)	Pre-implementation (B)	Post-implementation (C)	Difference, p value	
				A vs. B	B vs. C
PAC Use (%) Mean ± STD, Median (Q1–Q3)					
Acute Myocardial Infarction	31.2 ± 20.7, 32.3 (17.0–44.3)	32.4 ± 23.0, 33.1 (16.7–46.7)	32.3 ± 22.4, 32.6 (18.6–44.5)	0.007	0.73
Heart Failure	32.6 ± 18.4, 34.1 (19.8–44.9)	34.4 ± 19.5, 36.1 (21.3–48.0)	35.8 ± 19.9, 38.2 (22.2–49.7)	<0.001	<0.001
Pneumonia	31.9 ± 17.6, 33.3 (20.0–43.7)	32.5 ± 18.1, 33.9 (20.2–44.8)	33.3 ± 18.3, 35.5 (20.4–45.9)	0.12	0.03
30-Day Risk-Standardized Readmission (%) Mean ± STD, Median (Q1–Q3)					
Acute Myocardial Infarction	29.0 ± 2.9, 28.9 (27.2–30.7)	27.4 ± 2.5, 27.2 (25.7–28.8)	24.0 ± 1.9, 23.7 (22.8–25.0)	<0.001	<0.001
Heart Failure	22.8 ± 0.3, 22.8 (22.7–23.0)	22.3 ± 0.3, 22.3 (22.2–22.5)	20.2 ± 0.2, 20.2 (20.1–20.4)	<0.001	<0.001
Pneumonia	15.6 ± 0.2, 15.6 (15.5–15.7)	15.7 ± 0.2, 15.7 (15.5–15.8)	14.4 ± 0.2, 14.4 (14.3–14.5)	<0.001	<0.001
Effect of PAC Use on 30-Day Risk-Standardized Readmission, by Period					
Acute Myocardial Infarction	–0.0164 (–0.0183, –0.0146)	–0.0120 (–0.0138, –0.0101)	–0.0100 (–0.0112, –0.0087)	<0.001	0.08
Heart Failure	0.0001 (–0.0003, 0.0004)	–0.0004 (–0.0007, –0.0001)	–0.0004 (–0.0006, –0.0001)	0.05	0.97
Pneumonia	0.0003 (0.0001, 0.0006)	0.0002 (–0.0001, 0.0005)	–0.0003 (–0.0005, –0.0001)	0.46	0.02

PAC: post-acute care; HRRP: Hospital Readmissions Reduction Program; STD: standard deviation.

Table 3.

Descriptive PAC Use (%), 30-Day Risk-Standardized Readmission (%) and the Estimated Effect of PAC Use on 30-Day Risk-Standardized Readmission by Period: **Non-Targeted Conditions**.

Condition	Pre-passage (A)	Pre-implementation (B)	Post-implementation (C)	Difference, p value	
				A vs. B	B vs. C
PAC Use (%) Mean ± STD, Median (Q1–Q3)					
Ischemic Stroke	53.4 ± 25.7, 61.1 (39.3–70.7)	53.7 ± 26.6, 61.1 (41.6–71.2)	53.3 ± 25.7, 60.5 (41.7–69.8)	0.49	0.39
THA/TKA	71.3 ± 30.1, 83.8 (51.8–95.6)	71.6 ± 30.4, 85.0 (52.4–96.1)	67.8 ± 30.7, 78.9 (47.0–94.2)	0.60	<0.001
Hip/Femur Fracture	73.8 ± 33.5, 90.9 (64.3–96.3)	77.3 ± 31.5, 92.0 (74.9–97.0)	75.6 ± 31.7, 90.8 (70.0–95.9)	<0.001	0.02
30-Day Risk-Standardized Readmission (%) Mean ± STD, Median (Q1–Q3)					
Ischemic Stroke	13.6 ± 0.2, 13.6 (13.4–13.7)	13.0 ± 0.2, 13.0(12.9–13.0)	11.5 ± 0.1, 11.5 (11.4–11.5)	<0.001	<0.001
THA/TKA	5.6 ± 0.2, 5.6 (5.5–5.7)	5.5 ± 0.2, 5.5 (5.4–5.6)	4.4 ± 0.1, 4.4 (4.3–4.4)	<0.001	<0.001
Hip/Femur Fracture	13.8 ± 0.3, 13.7(13.6–13.9)	13.2 ± 0.4, 13.2(13.0–13.4)	11.4 ± 0.2, 11.4(11.3–11.5)	<0.001	<0.001
Effect of PAC Use on 30-Day Risk-Standardized Readmission, by Period					
Ischemic Stroke	0.0000 (–0.0002, 0.0002)	0.0001 (–0.0000, 0.0003)	0.0001 (–0.0001, 0.0002)	0.58	0.77
THA/TKA	0.0002 (–0.0001, 0.0003)	0.0002 (0.0001, 0.0003)	0.0001 (0.0001, 0.0002)	0.93	0.78
Hip/Femur Fracture	–0.0014 (–0.0017, –0.0012)	–0.0018 (–0.0022, –0.0015)	–0.0010 (–0.0013, –0.0008)	0.10	<0.001

PAC: post-acute care; HRRP: Hospital Readmissions Reduction Program. THA/TKA: Total Hip Arthroplasty/Total Knee Arthroplasty.