Appendices for:

Report to Congress:

Social Risk Factors and Performance Under Medicare's Value-Based Payment Programs

United States Department of Health and Human Services

Office of the Assistant Secretary for Planning and Evaluation

Washington, D.C.

December 2016

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Appendix for Executive Summary: Summary of Program Findings, Strategies, and Considerations

The executive summary chapter of this report discusses the overall findings and considerations across the nine programs evaluated. Those overall findings arose from analyses that were conducted separately for each program and led to the formation of the three strategies and their corresponding considerations presented in the executive summary. However, each of these considerations applies somewhat differently to each program, depending on their applicability and the program structure.

Additionally, some programs have considerations that are so program-specific that they do not fit into the three-strategy framework that applies across programs. For example, for the Hospital Acquired Condition Reduction Program (HACRP), the department recommends that the HACRP be updated with AHRQ's revised PSI-90 measure.

A summary of the research questions, findings, and considerations are presented below. Each program's chapter in the full report provides additional detail on the findings and considerations.

I. The Hospital Readmissions Reduction Program (HRRP)

Research Questions

- Is there a relationship between beneficiary social risk and readmission rates?
- Is there a relationship between hospital social risk profile and readmission rates?
- Are hospitals that serve a high proportion of beneficiaries with social risk factors more likely to receive penalties under the Hospital Readmissions Reduction Program?
- How would potential policy options to address issues of social risk and performance in the Hospital Readmissions Reduction Program affect program penalties?

Key Findings:

<u>Underlying Relationships</u>

- Dually-enrolled beneficiaries had significantly greater odds of readmission than non-dually enrolled beneficiaries even within the same hospitals, an effect that was relatively similar across hospitals participating in the HRRP.

- There was also a significant hospital effect, suggesting that safety-net hospitals have other unmeasured differences in patient characteristics, provide poorer-quality care to prevent readmissions, or face other barriers that might be related to the availability of resources or community supports.

Program Impacts

- Under the current readmission measures, the differences between hospitals' risk-standardized readmission rates were much smaller than the differences in raw readmission rates.
- Thus, under the current program using the current risk-adjusted measures, the differences in penalties between safety-net and non-safety-net hospitals were small.

Policy Simulations

- Under the current condition-specific program, direct adjustment for dual enrollment or stratifying hospitals by Disproportionate Share Hospital (DSH) Index and then assigning penalties by strata could significantly close the gap in penalties between safety-net and non-safety-net hospitals.
- Rewarding within hospital improvement over previous years, though appealing philosophically, would not impact penalties for safety-net hospitals, even with a bonus for high DSH Index hospitals.
- Under the current penalty formula, moving to a hospital-wide readmission measure would increase penalties for all hospitals. This would also increase the disparity in penalties between safety-net and other hospitals, both in absolute and relative terms.

SUMMARY OF STRATEGIES AND CONSIDERATIONS
STRATEGY 1: Measure and Report Quality for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Measure developers should develop readmission measures and/or statistical approaches suitable for reporting of performance for beneficiaries with social risk factors, where feasible.
CONSIDERATION 2: Consider prospectively monitoring for potential unintended consequences. In particular, the cumulative penalties across the three hospital programs for providers that serve beneficiaries with social risk factors should be tracked.
STRATEGY 2: Set High, Fair Standards for All Beneficiaries
CONSIDERATION 1: Readmission measures used in the current program should continue to be examined to determine if adjustment for social risk factors is appropriate.
CONSIDERATION 2: The use of a hospital-wide readmissions measure for the HRRP should be pursued in the long term, as included in the President's budgets for FY 2017 and FY 2016. However, the hospital-wide measure with the current penalty formula creates larger penalties among a smaller number of hospitals and disproportionately impacts the safety net. Therefore, changes to the penalty formula, or additional strategies such as stratification, should be pursued if this measure is implemented.
CONSIDERATION 3: Program measures should be studied to determine whether differences in health status might underlie the observed relationships between social risk and performance, and whether

better adjustment for health status might improve the ability to differentiate true differences in performance between providers.
STRATEGY 3: Reward and Support Better Outcomes for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider providing additional financial incentives for achievement of low readmission rates for beneficiaries with social risk factors.
CONSIDERATION 2: Consider using existing or new quality improvement programs to provide targeted technical assistance for readmissions reduction to providers that serve beneficiaries with social risk factors.
CONSIDERATION 3: Consider developing demonstrations or models focusing on care innovation that may help reduce readmissions for beneficiaries with social risk factors.

II. The Hospital-Acquired Conditions Reduction Program (HACRP)

Research Questions

- Is there a relationship between beneficiary social risk and performance on the safety measures that comprise the Hospital-Acquired Conditions Reduction Program (HACRP)?
- Is there a relationship between hospital social risk profile and performance on the safety measures that comprise the program?
- Are hospitals that serve a high proportion of beneficiaries with social risk factors more likely to be penalized under the HACRP?
- How would potential policy options to address issues of social risk and performance in the HACRP affect penalties?

Key Findings:

<u>Underlying Relationships</u>

- Both beneficiary social risk (dual enrollment, disability as the original reason for Medicare entitlement, and Black race) and hospital makeup (highest quintile of disproportionate share hospital (DSH) payments, beneficiaries with disabilities, or beneficiaries identified as Black) were associated with higher rates of patient safety events in the PSI-90 measure, suggesting both beneficiary and hospital factors contribute to patient safety events.

<u>Program Impacts</u>

- Safety-net hospitals (defined as those in the top quintile of DSH Index) and hospitals with a higher proportion of Black beneficiaries were more likely to be penalized under the HACRP.

<u>Policy Simulations</u>

- Risk-adjusting the PSI-90 measure for beneficiary social risk and/or unmeasured medical complexity had minimal impact on penalties, as the PSI-90 makes up only a small portion of hospitals' total score under the HACRP.
- Adjusting CDC's Hospital-Acquired Infection measures at the hospital level for DSH Index as a proxy for beneficiary social risk, and average HCC scores as a proxy for medical complexity, reduced the differences in penalty status between safety-net and non-safety-net hospitals.
- Stratifying hospitals into two groups (safety-net and non-safety-net) to determine penalties equalized the proportion of hospitals penalized by safety-net status.
- Restructuring the program to a linear penalty performance and basing penalty calculations on base DRG payments instead of total IPPS payments reduced the likelihood of penalties for the safety-net and reduced their average penalty dollars.
- Rewarding improvement had a limited impact on penalties.
- Changes to the program finalized by CMS in the FY 2017 Hospital Inpatient PPS Final Rule (81 Fed. Reg. 162), which include harms-based weighting in the modified PSI-90 and winsorized z-scores, are expected to lead to higher penalty rates for safety-net hospitals, but better reflect performance differences and the severity of harms from safety events.

Strategies and Considerations for the HACRP

SUMMARY OF STRATEGIES AND CONSIDERATIONS
STRATEGY 1: Measure and Report Quality for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider enhancing data collection and developing statistical techniques to allow measurement and reporting of performance for beneficiaries with social risk factors on key patient safety and infection measures.
CONSIDERATION 2: Consider prospectively monitoring for potential unintended consequences of the HACRP; the cumulative penalties across the three hospital value-based purchasing programs should be tracked for hospitals that disproportionately serve beneficiaries with social risk factors.
STRATEGY 2: Set High, Fair Standards for All Beneficiaries
CONSIDERATION 1: Patient safety measures used in the current HACRP should continue to be examined to determine if adjustment for social risk factors is appropriate.
CONSIDERATION 2: The HACRP should be updated with AHRQ's revised PSI-90 measure, as CMS plans to do in FY2018.
CONSIDERATION 3: Consider restructuring the HACRP to minimize differential impacts on hospitals disproportionately serving beneficiaries with social risk factors and incent improvement along the continuum of performance by determining penalties using base DRG payments and using a linear penalty scale rather than a binary penalty, with a continuous scoring approach, as included in the President's FY 2016 budget.
CONSIDERATION 4: Program measures should be studied to determine whether differences in health status might underlie the observed relationships between social risk and performance, and whether better adjustment for health status might improve the ability to differentiate true differences in performance between providers. In particular, patient-level clinical data from the CDC healthcare

associated infection measures should be examined and considered for risk adjustment. A long-term alternative would be to develop alternate safety measures such as all-harms measures using EHR data.
STRATEGY 3: Reward and Support Better Outcomes for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider providing additional financial incentives for hospitals that achieve low patient safety event rates and/or infection rates among beneficiaries with social risk factors.
CONSIDERATION 2: Consider using existing or new quality improvement programs to provide targeted technical assistance to providers that serve beneficiaries with social risk factors.
CONSIDERATION 3: Consider developing demonstrations or models focusing on care innovations to achieve low patient safety event rates and/or infection rates for beneficiaries with social risk factors.

III. The Hospital Value-Based Purchasing Program (HVBP)

Research Questions

- Is there a relationship between patient social risk and performance on the metrics that comprise the Hospital Value-Based Purchasing (HVBP) program?
- Is there a relationship between hospital social risk profile and performance on the metrics that comprise the program?
- Are hospitals that serve a high proportion of beneficiaries with social risk factors more likely to receive penalties under this program?
- What impact would policy options, including adjustment and stratification, have on hospitals performance and bonuses or penalties?

Key Findings:

Underlying Relationships

- Dually-enrolled beneficiaries had higher spending per care episode, as modeled using the Medicare Spending per Beneficiary parameters; differences were primarily driven by post-acute spending, both in terms of the frequency of use of more expensive settings and the spending within each setting.
- Social risk factors were generally protective for 30-day mortality measures, with the exception of disability and rural status, which were associated with higher mortality at both the beneficiary and hospital level.

Program Impacts

- The worse performance by safety-net hospitals (defined as the top 20% of disproportionate share hospital (DSH) index) on the total HVBP performance score was driven primarily by poor performance on patient experience measures. These hospitals also performed slightly worse than non-safety-net hospitals on process of care measures and efficiency, and on the patient

safety components of the outcome domain. However, safety-net hospitals performed equivalently to other hospitals on the mortality components of the outcome domain.

- Safety-net hospitals were more likely to receive penalties and less likely to receive bonuses under HVBP.

Policy Simulations

- Adjusting the MSPB efficiency measure for dual status and removing the patient safety measures from the HVBP program were associated with slight improvements in performance for safety-net providers.

Strategies and Considerations for HVBP

SUMMARY OF STRATEGIES AND CONSIDERATIONS
STRATEGY 1: Measure and Report Quality for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider enhancing data collection and developing statistical techniques to allow measurement and reporting of performance for beneficiaries with social risk factors on key hospital quality and resource use measures.
CONSIDERATION 2: Consider developing key hospital quality and resource use measures and/or statistical approaches suitable for reporting of performance for beneficiaries with social risk factors, where feasible.
CONSIDERATION 3: When feasible, consider developing and introducing a health equity measure or domain into the HVBP program to measure disparities and incent a focus on reducing them.
CONSIDERATION 4: Consider prospectively monitoring for potential unintended consequences. In particular, the cumulative penalties across the three hospital programs for providers that serve beneficiaries with social risk factors should be tracked.
STRATEGY 2: Set High, Fair Standards for All Beneficiaries
CONSIDERATION 1: The measures used in the current HVBP program should continue to be examined to determine if adjustment for social risk factors is appropriate.
CONSIDERATION 2: Program measures should be studied to determine whether differences in health status might underlie the observed relationships between social risk and performance, and whether better adjustment for health status might improve the ability to differentiate true differences in performance between providers.
STRATEGY 3: Reward and Support Better Outcomes for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider providing additional financial incentives for achievement and/or improvement in quality and outcomes in beneficiaries with social risk factors.
CONSIDERATION 2: Consider using existing or new quality improvement programs to provide targeted technical assistance to hospitals that disproportionately serve beneficiaries with social risk factors.
CONSIDERATION 3: Consider developing demonstrations or models focusing on care innovations that may help achieve better outcomes for beneficiaries with social risk factors who are hospitalized.

IV. Medicare Advantage (MA)

Research Questions

- Is there a relationship between beneficiary social risk and performance on the metrics that comprise the Medicare Advantage Quality Star Rating program?
- Is there a relationship between contract social risk profile and performance on the metrics that comprise the program?
- Are contracts that serve a high proportion of beneficiaries with social risk factors less likely to receive bonuses under this program?
- What impact would policy options, including adjustment and stratification, have on contracts' performance and bonuses?

Key Findings:

Underlying Relationships

- Dually-enrolled or low-income-subsidy, Black, and rural beneficiaries, beneficiaries living in low-income neighborhoods, and beneficiaries with disabilities experienced worse outcomes compared to other beneficiaries on many to most of the quality metrics included in the MA Quality Star Rating program. These differences were small to moderate in size, and largely driven by patient rather than contract factors. Hispanic beneficiaries had better outcomes on most measures.

Program Impact

- Contracts with a high proportion of beneficiaries with social risk factors generally did worse on overall quality scores, and were much less likely to receive quality bonus payments. However, a small number of contracts serving predominantly dually-enrolled / low-income subsidy-enrolled beneficiaries performed well on the quality measures overall.

Policy simulations

- Adjusting for social risk at the measure level, either directly or using an index, led to small changes in performance scores for contracts overall, though there were small gains in high-dual contracts; changes were small because the differences in performance between dually-enrolled and non-dually-enrolled beneficiaries were small for some measures, and because only the patient-level clinical measures were adjusted, and no adjustments were applied to patient experience measures (because they are already adjusted for social risk) or contract-level measures.
- Upweighting the improvement measure had a limited impact.
- Stratifying contracts by proportion dual led to changes in Star Ratings; using population grouping to stratify within contracts also led to changes in Star Ratings.
- Providing star adjustments for improvement or achievement in beneficiaries with social risk factors, or for equity, led to changes in Star Ratings.

Strategies and Considerations for MA

SUMMARY OF STRATEGIES AND CONSIDERATIONS
STRATEGY 1: Measure and Report Quality for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider enhancing data collection and developing statistical techniques to allow measurement and reporting of performance for beneficiaries with social risk factors, or for subgroups of plans (e.g., special needs plans) on key quality measures.
CONSIDERATION 2: Measure developers should develop measures that are meaningful for Medicare beneficiaries with disabilities, where many current measures do not apply.
CONSIDERATION 3: Consider developing and introducing a new measure or domain on Achieving Health Equity into the MA program to assess and reward health plan efforts to reduce health disparities.
CONSIDERATION 4: Prospectively monitor the financial impact of the MA program on providers disproportionately serving beneficiaries with social risk factors.
STRATEGY 2: Set High, Fair Standards for All Beneficiaries
CONSIDERATION 1: A temporary adjustment index by contracts' dual and disability makeup should be used in the short term, as outlined in the 2017 Rate Announcement and Call Letter. The measures used in the current MA program should continue to be examined to determine if adjustment for social risk factors is appropriate.
CONSIDERATION 2: Program measures should be studied to determine whether differences in health status might underlie the observed relationships between social risk and performance, and whether better adjustment for health status might improve the ability to differentiate true differences in performance between providers.
STRATEGY 3: Reward and Support Better Outcomes for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider providing targeted star adjustments to reward contracts that achieve high quality or improve significantly for dually-enrolled beneficiaries.
CONSIDERATION 2: Consider using existing or new quality improvement programs to provide targeted technical assistance to contracts serving a high proportion of beneficiaries who are dually-enrolled or who have disabilities.
CONSIDERATION 3: Consider requiring that contracts serving dually-enrolled beneficiaries coordinate benefits between Medicare and Medicaid. Barriers to integration of services between the two payers as well as barriers to spending flexibility for supplemental benefits for dually-enrolled beneficiaries should be minimized where feasible.
CONSIDERATION 4: Consider developing demonstrations or models focusing on care innovations that may help achieve better outcomes for beneficiaries with social risk factors.
CONSIDERATION 5: Consider further research to examine the costs of caring for beneficiaries with social risk factors to determine whether current payments adequately account for differences in care needs.

V. The Medicare Shared Savings Program (MSSP)

Research Questions

- Is there a relationship between beneficiary social risk and performance on the cost and quality measures that comprise the Medicare Shared Savings Program (Medicare Shared Savings Program)?
- Is there a relationship between Accountable Care Organization (ACO) social risk profile and performance on the cost and quality measures that comprise the program?
- Are ACOs that serve a high proportion of beneficiaries with social risk factors less likely to share in savings under the Medicare Shared Savings Program?
- How would potential policy options to address issues of social risk and performance in the Medicare Shared Savings Program affect shared savings?

Key Findings:

Underlying Relationships

- Dually-enrolled and Black beneficiaries, as well as beneficiaries with disabilities, were more likely to be readmitted, even after controlling for differences in patient risk. These disparities were very similar to those found in the HRRP analyses (Chapter 5), though the raw readmission rates in ACO beneficiaries in general were lower than those seen in the overall FFS population.
- Within the same ACO, dually-enrolled, Black, and Hispanic, beneficiaries, as well as beneficiaries with disabilities and those from low-income ZCTAs, had greater odds of being admitted for COPD (but not for HF) than other beneficiaries, even after risk-adjustment.
- Beneficiary-level factors were generally a larger contributor to readmission rates than ACO-level factors. Beneficiaries in high-dual, high-disabled, and high-Black ACOs were more likely to have preventable admissions for COPD, even once patient clinical risk was taken into consideration.

Cost and Quality Performance among ACOs Serving Socially at-risk Populations

- ACOs in the highest quintile of the proportion of beneficiaries with social risk factors served had comparable scores on the majority of quality measures to ACOs serving an average population.
- ACOs in the highest quintile of the proportion of beneficiaries with social risk factors served had, on average, higher cost benchmarks than ACOs serving an average population.
- In general, ACOs serving beneficiaries with social risk factors had greater savings and were more likely to share in savings relative to ACOs overall.

Policy Simulations

- Providing a bonus for ACOs that served a high-dual population increased per-beneficiary savings.
- Moving to a regional benchmark was associated with higher absolute savings for high-dual ACOs but created a disparity between these and other ACOs in achieving shared savings.

Strategies and Considerations for the Medicare Shared Savings Program

SUMMARY OF STRATEGIES AND CONSIDERATIONS
STRATEGY 1: Measure and Report Quality for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider enhancing data collection and developing statistical techniques to allow measurement and reporting of performance for beneficiaries with social risk factors on key quality and resource use measures.
CONSIDERATION 2: Measure developers should develop key quality and resource use measures and/or statistical approaches suitable for reporting of performance for beneficiaries with social risk factors.
CONSIDERATION 3: When feasible, consider developing and introducing a new measure or domain on Achieving Health Equity to the Medicare Shared Savings Program to assess and reward ACO efforts to reduce health disparities.
CONSIDERATION 4: Prospectively monitor costs and savings for ACOs disproportionately serving high proportions of dually-enrolled beneficiaries as the benchmark rebasing methodology that accounts for factors based on FFS spending in the ACO's regional service area takes effect.
STRATEGY 2: Set High, Fair Standards for All Beneficiaries
CONSIDERATION 1: The measures used in the Medicare Shared Savings Program should continue to be examined to determine if adjustment for social risk factors is appropriate.
CONSIDERATION 2: Ambulatory care-sensitive condition admission measures should account for medical risk, as CMS has announced will be done in future program years (see 2017 PFS final rule, published November 2016).
CONSIDERATION 3: Program measures should be studied to determine whether differences in health status might underlie the observed relationships between social risk and performance, and whether better adjustment for health status might improve the ability to differentiate true differences in performance between providers. Attention should also be given to developing quality and outcome measures specifically designed for the ACO setting.
STRATEGY 3: Reward and Support Better Outcomes for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider providing additional financial incentives to reward ACOs that achieve high quality or significant improvement specifically among their beneficiaries with social risk factors.
CONSIDERATION 2: Consider providing targeted technical assistance to ACOs that disproportionately serve beneficiaries with social risk factors to help improve quality.
CONSIDERATION 3: Consider developing demonstrations or models focusing on care innovations that may help achieve better outcomes for beneficiaries with social risk factors in ACOs.
CONSIDERATION 4: Consider further research to examine the costs of caring for beneficiaries with social risk factors.

VI. The Physician Value-Based Payment Modifier (VM) Program

Research Questions

- Is there a relationship between beneficiary social or medical risk and performance on the metrics that comprise the Physician Value-Based Payment Modifier program?
- Is there a relationship between practice social or medical risk profile and performance on the metrics that comprise the program?
- Are practices that serve a high proportion of socially or medically at-risk individuals more likely to receive penalties under this program?
- What impact would policy options, including adjustment and stratification, have on practices' performance and bonuses or penalties?

Key Findings

Underlying Relationships

- Dually-enrolled and complex beneficiaries had higher readmission and ambulatory care-sensitive condition (ACSC) admission rates, even after adjustment for medical comorbidities and even within the same practice.
- Practices serving a high proportion of dually-enrolled or complex beneficiaries also had higher readmission and ACSC rates, even after adjustment for medical comorbidities and social risk factors. Practice effects were generally substantially smaller than the patient effects.
- Dually-enrolled beneficiaries had higher costs of care than other beneficiaries, even after risk adjustment and even within the same practices.
- Complex beneficiaries had lower costs of care than other beneficiaries, after accounting for medical risk and within the same practices.
- Practices serving a high proportion of dually-enrolled beneficiaries had similar or higher costs of care than other practices, after accounting for beneficiary dual enrollment. This was associated with both beneficiary and practice characteristics, although beneficiary effects were generally larger than practice effects.
- Practices serving a high proportion of complex beneficiaries had higher costs of care, even after accounting for beneficiary medical risk. This was primarily driven by practice effects.

Program Impacts

- Many practices did not successfully meet program requirements (failed to self-nominate for the PQRS as a group and report at least one measure, or failed to elect the PQRS administrative claims option) for the Physician VM Program. This was the most common reason for a downward adjustment in the program's first year. High-dual practices were twice as likely as other practices to fail to meet requirements for the program.
- High-dual practices were at higher risk of receiving a downward payment adjustment.
- High-complexity practices were at higher risk of receiving a downward payment adjustment.

Policy Simulations

- Adjusting readmission and ambulatory care-sensitive admission measures for dual enrollment had a negligible impact on payment adjustments.
- Adding medical risk adjustment to the ambulatory care-sensitive admission measures had a negligible impact on payment adjustments.
- Stratification equalized payment adjustments for high-dual versus other practices, but had a smaller effect on equalizing payment adjustments for high-complexity versus other practices.
- Adjusting cost measures for dual enrollment had little impact on payment adjustments.

Note: Since the VM program ends in 2018, strategies and considerations are provided to help with decision making for the Merit-based Incentive Payment System (MIPS), and generally are not feasible for implementation in VM given that timeframe.

Strategies and Considerations for Physician VM

SUMMARY OF STRATEGIES AND CONSIDERATIONS
STRATEGY 1: Measure and Report Quality for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider enhancing data collection and developing statistical techniques to allow measurement and reporting of performance for beneficiaries with social risk factors on key quality and resource use measures.
CONSIDERATION 2: When feasible, consider developing and introducing a new measure or domain on Achieving Health Equity to MIPS to assess and reward physician practice efforts to reduce health disparities.
CONSIDERATION 3: Consider prospectively monitoring for potential unintended consequences in the current Physician VM program and in the MIPS program as it is implemented.
STRATEGY 2: Set High, Fair Standards for All Beneficiaries
CONSIDERATION 1: The measures used in the Physician VM Program should continue to be examined to determine if adjustment for social risk factors is appropriate.
CONSIDERATION 2: The ambulatory care-sensitive condition measures should be updated to account for medical risk.
CONSIDERATION 3: Program measures should be studied to determine whether differences in health status might underlie the observed relationships between social risk and performance, and whether better adjustment for health status might improve the ability to differentiate true differences in performance between practices.
STRATEGY 3: Reward and Support Better Outcomes for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider providing additional payment adjustments for practices that disproportionately serve beneficiaries with social risk factors and achieve high quality, or specifically for achieving high quality in beneficiaries with social risk factors.
CONSIDERATION 2: Consider using existing or new quality improvement programs to provide targeted

technical assistance to practices that disproportionately serve beneficiaries with social risk factors to help improve quality and ensure they can successfully participate in the reporting required for the MIPS program, or to assist in moving toward alternative payment model (APM) participation.
CONSIDERATION 3: Consider developing demonstrations or models focusing on care innovations that may help achieve better outcomes for beneficiaries with social risk factors.
CONSIDERATION 4: Consider further research to examine the costs of caring for beneficiaries with social risk factors and to determine whether current payments adequately account for these differences in care needs.

VII. The End-Stage Renal Disease Quality Incentive Program (ESRD QIP)

Research Questions

- Is there a relationship between beneficiary social risk and performance on the metrics that comprise the End-Stage Renal Disease Quality Incentive Program?
- Is there a relationship between facility social risk profile and performance on the metrics that comprise the program?
- Are facilities that serve a high proportion of beneficiaries with social risk factors more likely to receive penalties under this program?

Key Findings:

- Beneficiaries with social risk factors have worse performance on many quality measures in the ESRD QIP, even within the same facilities.
- Facilities with a high proportion of beneficiaries with social risk factors were more likely to receive payment reductions. However, because so few facilities are penalized overall in the Quality Incentive Program, these significant relative differences in the likelihood of being penalized translate to small absolute differences in the number of facilities penalized.
- Measures that may be added to the program in future years are in areas where safety-net providers have traditionally performed more poorly.

Strategies and Considerations for the ESRD QIP

SUMMARY OF STRATEGIES AND CONSIDERATIONS
STRATEGY 1: Measure and Report Quality for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider enhancing data collection and developing statistical techniques to allow measurement and reporting of performance for beneficiaries with social risk factors on key quality and resource use measures.

CONSIDERATION 2: When feasible, consider developing and introducing a new measure or domain on Achieving Health Equity to the ESRD QIP to assess and reward facility efforts to reduce health disparities.
CONSIDERATION 3: Prospectively monitor the financial impact of the ESRD QIP on facilities disproportionately serving beneficiaries with social risk factors.
STRATEGY 2: Set High, Fair Standards for All Beneficiaries
CONSIDERATION 1: The measures used in the ESRD QIP should continue to be examined to determine if adjustment for social risk factors is appropriate.
CONSIDERATION 2: Program measures should be studied to determine whether differences in health status might underlie the observed relationships between social risk and performance, and whether better adjustment for health status might improve the ability to differentiate true differences in performance between facilities.
STRATEGY 3: Reward and Support Better Outcomes for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider providing additional financial incentives to reward facilities that achieve high quality or significant improvement for beneficiaries with social risk factors.
CONSIDERATION 2: Consider using existing or new quality improvement programs to provide targeted technical assistance to facilities that disproportionately serve beneficiaries with social risk factors to improve quality and ensure they can successfully participate in the reporting required for the ESRD QIP.
CONSIDERATION 3: Consider developing demonstrations or models focusing on care innovations that may help achieve better outcomes for beneficiaries with social risk factors.
CONSIDERATION 4: Consider further research to examine the costs of caring for beneficiaries with social risk factors and to determine whether current payments adequately account for these differences in care needs.

VIII. Skilled Nursing Facilities (SNF)

Research Questions

- Is there a relationship between beneficiary social risk and performance on quality measures in the Skilled Nursing Facility (SNF) setting?
- Is there a relationship between SNF social risk profile and performance on these metrics?

Key Findings:

- Analyses showed that beneficiaries at high social risk were much more likely to be re-hospitalized during the first 30 days of a SNF stay. However, after applying the risk adjustment variables to the model, these effects were significantly smaller, and the effect of dual enrollment disappeared.
- Similarly, by raw readmission rates, being at a SNF with a high proportion of dually-enrolled, low-income, Black, or Hispanic beneficiaries, or beneficiaries with disabilities, was associated with an

increased likelihood of re-hospitalization during the first 30 days of a SNF stay, regardless of a beneficiary's social risk. This result decreased with CMS risk adjustment, but remained significant.

- The exception to these findings was for rural beneficiaries and rural SNFs, where readmission rates were lower than in urban settings, but results were not statistically significant.
- When beneficiary and provider social risk factors were included in a single model, the provider level effect was in general larger than the beneficiary level effect.

Strategies and Considerations for the SNF setting

SUMMARY OF STRATEGIES AND CONSIDERATIONS
STRATEGY 1: Measure and Report Quality for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider developing SNF readmission measures and/or statistical approaches suitable for reporting of performance for beneficiaries with social risk factors, where feasible.
CONSIDERATION 2: When feasible, consider developing and introducing a new measure or domain on Achieving Health Equity to the SNF VBP program to assess and reward facility efforts to reduce health disparities.
CONSIDERATION 3: Consider increasing the number of metrics included in SNF VBP to be more reflective of a broader agenda for improving quality in this setting.
CONSIDERATION 4: As SNF VBP is implemented, consider prospectively monitoring for potential unintended consequences. Specifically, the potential for reducing access to care for beneficiaries perceived to be at high risk of readmission, such as dually-enrolled beneficiaries, beneficiaries with disabilities or individuals with multiple comorbidities, should be tracked.
STRATEGY 2: Set High, Fair Standards for All Beneficiaries
CONSIDERATION 1: The SNF readmission measure should continue to be examined to determine if adjustment for social risk factors is appropriate.
CONSIDERATION 2: Program measures should be studied to determine whether differences in health status might underlie the observed relationships between social risk and performance, and whether better adjustment for health status might improve the ability to differentiate true differences in performance between providers.
STRATEGY 3: Reward and Support Better Outcomes for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider providing additional financial incentives to reward skilled nursing facilities that achieve high quality or significant improvement for beneficiaries with social risk factors.
CONSIDERATION 2: Consider using existing or new quality improvement programs to provide targeted technical assistance to skilled nursing facilities that disproportionately serve beneficiaries with social risk factors to help improve quality.
CONSIDERATION 3: Consider developing demonstrations or models focusing on care innovations that may help achieve better outcomes for beneficiaries with social risk factors.
CONSIDERATION 4: Consider further research to examine the costs of caring for beneficiaries with social risk factors and to determine whether current payments adequately account for these differences in care needs.

IX. Home Health Agencies (HHA)

Research Questions

- Is there a relationship between beneficiary social risk and performance on quality measures in the Home Health Agency (HHA) setting?
- Is there a relationship between HHA social risk profile and performance on these metrics?

Key Findings:

- By raw rates, beneficiaries with social risk factors were much more likely to be re-hospitalized or use ED services during the first 30 days of home health care.
- CMS risk adjustment decreased the effect to some degree, but many social risk factors remained predictive of re-hospitalization and ED use at the beneficiary level. Results were more mixed at the provider level.
- In looking at the relative contribution of beneficiary-level versus provider-level effects, beneficiary dual enrollment and disability status were the dominant factors.

Strategies and Considerations for the Home Health Setting

SUMMARY OF STRATEGIES AND CONSIDERATIONS
STRATEGY 1: Measure and Report Quality for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider enhancing data collection and developing statistical techniques to allow measurement and reporting of performance for beneficiaries with social risk factors on key HHA quality and resource use measures.
CONSIDERATION 2: When feasible, consider developing and introducing a new measure or domain on Achieving Health Equity to the HHVBP program to assess and reward facility efforts to reduce health disparities.
CONSIDERATION 3: As HHVBP is implemented, consider prospectively monitoring for potential unintended consequences. Specifically, the potential for reducing access to care for beneficiaries perceived to be at high risk of readmission, such as dually-enrolled beneficiaries, beneficiaries with disabilities or individuals with multiple comorbidities, should be tracked.
STRATEGY 2: Set High, Fair Standards for All Beneficiaries
CONSIDERATION 1: The HHA readmission and ED use measures should continue to be examined to determine if adjustment for social risk factors is appropriate.
CONSIDERATION 2: Program measures should be studied to determine whether differences in health status might underlie the observed relationships between social risk and performance, and whether better adjustment for health status might improve the ability to differentiate true differences in performance between agencies.
STRATEGY 3: Reward and Support Better Outcomes for Beneficiaries with Social Risk Factors
CONSIDERATION 1: Consider providing additional financial incentives to reward agencies that achieve

high quality or significant improvement for beneficiaries with social risk factors.
CONSIDERATION 2: Consider using existing or new quality improvement programs to provide targeted technical assistance to providers that disproportionately serve beneficiaries with social risk factors to help improve quality.
CONSIDERATION 3: Consider exploring the potential under the HHA demonstration program to test care innovations particularly focused on beneficiaries with social risk factors.
CONSIDERATION 4: Consider further research to examine the costs of caring for beneficiaries with social risk factors and to determine whether current payments adequately account for these differences in care needs.

Appendix Chapter 1: Introduction

Appendix Table 1.1: Legislative Charge

One Hundred Thirteenth Congress of the United States of America AT THE SECOND SESSION. An Act To amend title XVIII of the Social Security Act to provide for standardized postacute care assessment data for quality, payment, and discharge planning, and for other purposes.

SECTION 1. SHORT TITLE.
This Act may be cited as the ''Improving Medicare Post-Acute Care Transformation Act of 2014'' or the ''IMPACT Act of 2014''.

SEC. 2. STANDARDIZATION OF POST-ACUTE CARE DATA. . . . . .

(d) IMPROVING PAYMENT ACCURACY UNDER THE PAC PAYMENT SYSTEMS AND OTHER MEDICARE PAYMENT SYSTEMS.—
(1) STUDIES AND REPORTS OF EFFECT OF CERTAIN INFORMATION ON QUALITY AND RESOURCE USE.—
(A) STUDY USING EXISTING MEDICARE DATA.—
(i) STUDY.—The Secretary of Health and Human Services (in this subsection referred to as the ''Secretary'') shall conduct a study that examines the effect of individuals' socioeconomic status on quality measures and resource use and other measures for individuals under the Medicare program under title XVIII of the Social Security Act (42 U.S.C. 1395 et seq.) (such as to recognize that less healthy individuals may require more intensive interventions). The study shall use information collected on such individuals in carrying out such program, such as urban and rural location, eligibility for Medicaid under title XIX of such Act (42 U.S.C. 1396 et seq.) (recognizing and accounting for varying Medicaid eligibility across States), and eligibility for benefits under the supplemental security income (SSI) program. The Secretary shall carry out this paragraph acting through the Assistant Secretary for Planning and Evaluation.
(ii) REPORT.—Not later than 2 years after the date of the enactment of this Act, the Secretary shall submit to Congress a report on the study conducted under clause (i).
(B) STUDY USING OTHER DATA.—
(i) STUDY.—The Secretary shall conduct a study that examines the impact of risk factors, such as those described in section 1848(p)(3) of the Social Security Act (42 U.S.C. 1395w–4(p)(3)), race, health literacy, limited English proficiency (LEP), and Medicare beneficiary activation, on quality measures and resource use and other measures under the Medicare program (such as to recognize that less healthy individuals may require more intensive interventions). In conducting such study the Secretary may use existing Federal data and collect such additional data as may be necessary to complete the study.
(ii) REPORT.—Not later than 5 years after the date of the enactment of this Act, the Secretary shall submit to Congress a report on the study conducted under clause (i).
(C) EXAMINATION OF DATA IN CONDUCTING STUDIES.—
In conducting the studies under subparagraphs (A) and (B), the Secretary shall examine what non-Medicare data sets, such as data from the American Community Survey (ACS), can be useful in conducting the types of studies under such paragraphs and how such data sets that are identified as useful can be coordinated with Medicare administrative data in order to improve the overall data set available to do such studies and for the administration of the Medicare program.
(D) RECOMMENDATIONS TO ACCOUNT FOR INFORMATION IN PAYMENT ADJUSTMENT MECHANISMS.—If the studies conducted under subparagraphs (A) and (B) find a relationship between the factors examined in the studies and quality measures and resource use and other measures, then the Secretary shall also provide recommendations for how the Centers for Medicare & Medicaid Services should—
(i) obtain access to the necessary data (if such data is not already being collected) on such factors, including recommendations on how to address barriers to the Centers in accessing such data; and
(ii) account for such factors—
(I) in quality measures, resource use measures, and other measures under title XVIII of the Social Security Act (including such measures specified under subsections (c) and (d)

of section 1899B of such Act, as added by subsection (a)); and
(II) in determining payment adjustments based on such measures in other applicable provisions of such title.

(E) FUNDING.—There are hereby appropriated to the Secretary from the Federal Hospital Insurance Trust Fund under section 1817 of the Social Security Act (42 U.S.C. 1395i) and the Federal Supplementary Medical Insurance Trust Fund under section 1841 of such Act (42 U.S.C.1395t) (in proportions determined appropriate by the Secretary) to carry out this paragraph $6,000,000, to remain available until expended.

END OF EXCERPT

Appendix Table 1.2: National Academies of Medicine Reports

Report Title	Link
Accounting for Social Risk Factors in Medicare Payment: Identifying Social Risk Factors (2016)	http://www.nationalacademies.org/hmd/Reports/2016/Accounting-for-Social-Risk-Factors-in-Medicare-Payment.aspx
Systems Practices for the Care of Socially At-Risk Populations (2016)	http://www.nationalacademies.org/hmd/Reports/2016/Systems-Practices-for-the-Care-of-Socially-At-Risk-Populations.aspx
Report on potential criteria and methods for addressing Social Risk Factors	Forthcoming
Report on existing or new Social Risk Factors data sources	Forthcoming

Appendix Tables 1.3a-e: Workgroups

A. Hospital Value-Based Payment Programs Workgroup

Hospital Workgroup
Blatt, Jody (CMS/CMMI)
Brea, Michael (CMS/CM)
Carr, Brendan (OS/ASPR/OPP)
Cheng, Ing Jye (CMS/CM)
Clift, Joseph B. (CMS/CCSQ)
Go, Kimberly (CMS/CM)
Goldstein, Elizabeth H. (CMS/CM)
Goodrich, Kate (CMS/CCSQ)
Han, Lein F. (CMS/CCSQ)
Hayden, Megan R. (CMS/CCSQ)
Houseal, Delia L. (CMS/CCSQ)
Im, Grace H. (CMS/CCSQ)
James, Cara V. (CMS/OMH)

Larbi, Fiona M. (CMS/CM)
Lee, Allison K. (CMS/CM)
Lehrman, William G. (CMS/CM)
Lipschutz, Tehila (CMS/CM)
Meyyur, Vinitha (CMS/CCSQ)
Moore, Paul (HRSA)
Mueller, Curt (HRSA)
Nichols, Debra (CMS/CCSQ)
Obi, Chioma (CMS/CM)
Pilotte, John C. (CMS/CM)
Pollock, Daniel (CDC/OID/NCEZID)
Poyer, James M. (CMS/CCSQ)
Ricksecker, Elizabeth G. (CMS/FCHCO)
Rodgers, Tricia L. (CMS/CM)
Spalding Bush, Kimberly (CMS/CM)
Tefera, Lemeneh (CMS/CCSQ)
Thompson, Donald (CMS/CM)
Thompson, Shaneka N. (CMS/CCSQ)
Tourison, Cindy (CMS/CCSQ)
Wetherson, David (CMS/CCSQ)
Yong, Pierre L. (CMS/CCSQ)

B. Medicare Advantage Quality Star Rating Program Workgroup

MA Workgroup
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Gaillot, Sarah (CMS/CM)
Goldstein, Elizabeth H. (CMS/CM)
James, Cara V. (CMS/OMH)
Kelman, Jeffrey A. (CMS/CM)
Ketcham, Michelle B. (CMS/CM)
Larrick, Amy (CMS/CM)
Lee-Martin, Alice C. (CMS/CM)
McDowell, Audrey (HHS/ASPE)
McNally, Diane (CMS/CM)
Miranda, David J. (CMS/CM)
Moore, Paul (HRSA)
Mueller, Curt (HRSA)
Ricksecker, Elizabeth G. (CMS/FCHCO)
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C. MSSP and Physician VM Workgroup

MSSP and Physician VM Workgroup
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Moore, Paul (HRSA)
Mueller, Curt (HRSA)
Nolan, Thomas P. (CMS/OACT)
ONeal, Judith (HHS/ASPE)
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Prachanronarong, Aucha (CMS/CCSQ)
Precht, Paul (CMS/FCHCO)
Ricksecker, Elizabeth G. (CMS/FCHCO)
Sharp, James P. (CMS/CMMI)
Skapik, Julia (HHS/ONC)
Spalding Bush, Kimberly (CMS/CM)
Tefera, Lemeneh (CMS/CCSQ)
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Thomas, Megan (CMS/CMCS)
Yong, Pierre L. (CMS/CCSQ)

D. End-Stage Renal Disease Quality Incentive Program Workgroup

ESRD Workgroup
Anane, Thomasina P. (CMS/CMMI)
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Balovlenkov, Elena (CMS/CCSQ)
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Duvall, Tom (CMS/CMMI)
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Garcia, Tamyra C. (CMS/CCSQ)
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Lee, Allison K. (CMS/CM)
Mueller, Curt (HRSA)
Yong, Pierre L. (CMS/CCSQ)

E. Post-Acute Value-Based Payment Programs Workgroup

Post-Acute Workgroup
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Harvilchuck, Judith (CMS/CCSQ)
Hudson, Michele L. (CMS/CM)
James, Cara V. (CMS/OMH)
Kane, John A. (CMS/CM)
Kennedy, Gavin (HHS/ASPE)
Laberge, Alexandre (CMS/CMMI)
Lash, Sharon (CMS/CCSQ)
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Lipkin, Emily S. (CMS/CM)
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Mandl, Stella R. (CMS/CCSQ)
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McMullen, Tara L. (CMS/CCSQ)
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Schroder, Daniel (CMS/CM)
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Searcy, Talisha (OS/ONC)
Sevast, Patricia A. (CMS/CCSQ)
Smith, Michael R. (CMS/CMCS)
Thompson, Donald (CMS/CM)
Vontran, Kelly A. (CMS/CM)
Woody, Iara (OS/ASPE)

Appendix Table 1.4: Technical Expert Panels

Member	Affiliation
Hospital Programs	
John Birkmeyer, MD	Professor of Surgery, Executive Vice President, Integrated Delivery System and Chief Academic Officer at Dartmouth-Hitchcock Medical Center
David Cutler, PhD	Harvard College Professor, Otto Eckstein Professor of Applied Economics, Harvard University
Steve Jencks, MD, MPH	Consultant in Healthcare Quality and Safety
Bruce Landon, MD, MBA, MSc	Professor of Health Care Policy, Harvard Medical School and Professor of Medicine, Beth Israel Deaconess Medical Center
Mark Miller, PhD	Executive Director, Medicare Payment Advisory Commission
Patrick Romano, MD, MPH	Professor of General Medicine and Pediatrics, University of California-Davis School of Medicine
Alan Zaslavsky, PhD	Professor of Health Care Policy, Harvard Medical School
Richard Kronick	Director of the Agency for Healthcare Research and Quality
Medicare Advantage	
John Ayanian, MD, MPP	Inaugural director of the Institute for Healthcare Policy and Innovation (IHPI) at the University of Michigan
Karen Davis, PhD	Eugene and Mildred Lipitz Professor in the Department of Health Policy and Management and Director of the Roger C. Lipitz Center for Integrated Health Care at the Bloomberg School of Public Health at Johns Hopkins University
Paul Ginsburg, PhD	Norman Topping Chair in Medicine and Public Policy and Professor at the Sol Price School of Public Policy at University of Southern California
Marsha Gold, ScD	Senior fellow emeritus (Mathematica Policy Research) and independent consultant
Sharon-Lise Normand, PhD	Professor of Health Care Policy in the Department of Health Care Policy at Harvard Medical School and Professor in the Department of Biostatistics at the Harvard School of Public Health
Stephen Schondelmeyer, PharmD, PhD	Professor of Pharmaceutical Economics in the College of Pharmacy at the University of Minnesota

Mark Miller, PhD	Executive Director, Medicare Payment Advisory Commission
Richard Kronick, PhD	Director of the Agency for Healthcare Research and Quality
Christine Hunter, MD	Chief Medical Officer, U.S. Office of Personnel Management
Medicare Shared Savings Program and Physician Value-Based Payment Modifier	
David Asch, MD, MBA	Executive Director of the Penn Medicine Center for Health Care Innovation
Lawrence Casalino, MD, PhD	Livingston Farr Professor of Public Health and Chief of the Division of Health Policy and Economics in the Department of Healthcare Policy and Research at Weill Cornell Medical College
J. Michael McWilliams, MD, PhD	Associate Professor of Health Care Policy and Medicine at Harvard Medical School and a practicing general internist at Brigham and Women's Hospital
Meredith Rosenthal, PhD	Professor of Health Economics and Policy and the Associate Dean of Diversity at the Harvard T.H. Chan School of Public Health
Eric Schneider, MD, MSc	Senior Vice President for policy and research at The Commonwealth Fund
Stephen M. Shortell, PhD, MPH, MBA	Blue Cross of California Distinguished Professor of Health Policy and Management and Professor of Organization Behavior at the School of Public Health and Haas School of Business at University of California-Berkeley
Richard Kronick, PhD	Director of the Agency for Healthcare Research and Quality
Mark Miller, PhD	Executive Director, Medicare Payment Advisory Commission
End-Stage Renal Disease	
Alan Kliger, MD	Clinical Professor of Medicine, Yale University School of Medicine, and Vice President, Chief Quality Officer, Yale New Haven Health System
Neil Powe, MD, MPH, MBA	Professor, University of California at San Francisco School of Medicine, and Chief of Medicine, San Francisco General Hospital
Richard Hirth, PhD	Associate Chair, Department of Health Management and Policy at University of Michigan School of Public Health
Steven Fishbane, MD	Chief of Nephrology for North Shore University Hospital and Long Island Jewish Medical Center

Appendix Chapter 2: Social Risk Factors

Appendix Table 2.1: Types of Dual Medicaid / Medicare Eligibility

Program	Income Criteria	Resource Criteria	Benefits
Partial-Benefit Groups			
QMB only	≤100% of FPL	≤2x SSI resource limit	Medicaid pays Medicare Part A and B premiums, and Medicare cost-sharing. Beneficiary does not receive full Medicaid benefits.
SLMB only	>100% but <120% of FPL	≤2x SSI resource limit	Medicaid pays Part B premiums only. Beneficiary does not receive full Medicaid benefits.
QDWI	≤200% of FPL	≤2x SSI resource limit	Medicaid pays Part A premiums only. Beneficiary does not receive full Medicaid benefits.
QI	≥120% but <135% of FPL	≤2x SSI resource limit	Medicaid pays Part B premiums only. Beneficiary does not receive full Medicaid benefits.
Full-Benefit Groups			
QMB plus	≤100% of FPL	≤2x SSI resource limit	Medicaid pays Medicare Part A and B premiums, and Medicare cost-sharing. Beneficiary also receives full Medicaid benefits.
SLMB plus	>100% but <120% of FPL	≤2x SSI resource limit	Medicaid pays Part B premiums. Beneficiary also receives full Medicaid benefits, but with limits on overlap with Medicare coverage.
Other full-benefit dual-eligible	≤100% of FPL	Typically need to spend down to qualify	Medicaid provides full Medicaid benefits, but with limits on overlap with Medicare coverage; may cover Part B premiums. Details may vary by state.

QDWI = Qualified Disabled and Working Individuals. QI = Qualifying Individuals. QMB = Qualified Medicare Beneficiaries. SLMB = Specified Low-Income Medicare Beneficiaries. SSI = Supplemental Security Income.

Appendix Chapter 3: Statistical Methods

No additional material; see program chapters for program-specific methods appendices.

Appendix Chapter 4: Best Practices

No additional material. See http://www.nationalacademies.org/hmd/Reports/2016/Systems-Practices-for-the-Care-of-Socially-At-Risk-Populations.aspx for full National Academies of Medicine report referenced in this chapter.

Appendix Chapter 5: Hospital Readmissions Reduction Program

I. Detailed Methodology

A. Data

Beneficiary and hospital-level data for measures included in the Hospital Readmissions Reduction Program (HRRP) were used to assess the relationship between measures of social risk (a set of measures more comprehensive than SES) and hospital performance. Medicare fee-for-service (FFS) claims from fiscal years (FY) 2011-2013 (October 2010 –September 2013) were used to determine hospitals' three year condition specific readmission rates, the quality measure used for the HRRP. To simulate the effects of moving to a hospital-wide readmission measure, FY 2013 data was used to determine hospitals' one year hospital-wide readmission rate. Analyses included all acute care hospitals paid under the Inpatient Prospective Payment System (IPPS).

Hospital Excess Readmission Rates (ERRs) and Risk-Standardized Readmission Rates (RSRRs) were simulated using the 2014 measure update specifications for all measures. These were five condition specific measures: (1) AMI, (2) heart failure, (3) pneumonia, (4) COPD; (5) THA/TKA. Current and archived measure specification reports are available at https://www.qualitynet.org.

B. Measures of Social Risk

Multiple measures of social risk were examined for their association with performance on the quality measures and impact on the Star Ratings (Table 2). Each measure of social risk was constructed as a dichotomous variable, with "1" meaning the beneficiary had that social risk measure (e.g. resided in a rural area) and "0" indicating the beneficiary did not experience that measure of social risk. Measures derived from the census data were coded a "1" if the beneficiary resided in a ZCTA that was in the most at risk quintile of ZCTAs for the social risk factor being measured (e.g., the ZCTA was in the lowest quintile for median income). Additional related risk factors (such as disability) were also examined.

Appendix Table 5.1. Measures of Social and Related Risk

Social and Related Risk Category	Beneficiary-level variable
Poverty (dual eligibility)	Dual status (full or partial dual enrollment at any point in the calendar year)
Poverty (ZCTA-level income)	ZCTA-level income (from Census data)
Education	ZCTA-level educational attainment (from Census data)
English language proficiency	ZCTA-level English proficiency (from Census

	data)
Employment rate	ZCTA-level employment rate (from Census data)
Home value	ZCTA-level median home value (from Census data)
Race/ethnicity (beneficiary level): black versus non-black	Race/ethnicity (from Medicare enrollment file)
Race/ethnicity (beneficiary level): Hispanic versus non-Hispanic	Race/ethnicity (from Medicare enrollment file)
Race/ethnicity (ZCTA-level)	ZCTA-level racial/ethnic composition (from Census data)
Rurality	Home zip outside MSA
Disability	Original reason for Medicare entitlement (from Medicare enrollment file)

C. Association between Beneficiary-Level Social Risk and Performance

The beneficiary-level analyses focused primarily on the social risk factor of poverty as measured by dual eligibility, and secondarily on race/ethnicity at the beneficiary level, rurality, and disability. Three models were evaluated for each measure: (1) the social risk measure as the only predictor, (2) each social risk factor with the HRRP risk adjustment variables, and (3) all 11 social risk measures listed in Table 5.1 and the HRRP risk adjustment variables. These analyses focused on estimating the average within-hospital social risk disparity including hospital specific intercepts based on hospital level random effects.

Additionally, for the primary social risk factor of poverty, a separate specification evaluated the hospital specific effect of dual status on readmission rate. A random slope for the dual enrollment was added to the models (essentially adding an interaction between dual enrollment and the hospital random effect). The model built upon Model 2 including the HRRP risk adjustment variables. The predicted values for the hospital specific random slopes were used to determine the consistency of the effect of being dually eligible on likelihood of readmission across hospitals.

D. Association between Hospital-Level Social Risk and Performance

Another set of analyses evaluated the association between hospital measures of social risk and readmission rates using beneficiary level data. These analyses refer to hospitals treating high social risk patients as safety-net hospitals. Safety-net status is in turn defined as being in the top 20% of the distribution of hospitals by DSH Index or DSH patient percentage. The formula for a hospital's DSH patient percentage is based on the number of Medicare dual eligible patients and the number of Medicaid patients, and can be found on the CMS website at https://www.cms.gov/medicare/medicare-fee-for-service-payment/acuteinpatientpps/dsh.html.

These hospital-level analyses followed the same structure as the beneficiary-level social risk factor modeling, using three specifications to evaluate the between hospital difference in readmission rates. These models also included hospital random intercepts with the following covariates: (1) safety-net

status as the only predictor, (2) safety-net status with the HRRP risk adjustment variables, and (3) safety-net status all 11 social risk measures listed in Table 5.1 and the HRRP risk adjustment variables.

E. Policy Simulations

HRRP penalties were simulated using the formulas published in the FY 2013 IPPS rule, described in detail at https://www.cms.gov/medicare/medicare-fee-for-service-payment/acuteinpatientpps/readmissions-reduction-program.html and below. These penalties were evaluated based on the simulated ERRs for the five conditions, as described above, considered the baseline ERRs. Policy simulations compared changes in penalties for all hospitals eligible for the HRRP, as well as for safety-net and other hospitals separately, using hospitals' DSH index to determine safety-net status, as described above.

1. Adjust Readmission Rates for Social Risk Factors

This option included social risk factors along with age, sex, and medical comorbidities when determining hospitals' ERR. Two adjustments were considered: one including only the social risk factor of dual enrollment, and another including dual enrollment, rurality, ZIP code per-capita median income, and ZIP code average education attained. HRRP penalties were then evaluated using the penalty formulas from the FY 2013 IPPS rule.

2. Stratification

For stratification, hospitals were divided into groups and then penalties were evaluated within each group, rather than across all hospitals. Groups were created based on a hospital's DSH Index. Two different groupings were evaluated: (1) two strata of safety-net hospitals (the top quintile of hospitals by DSH Index) and all other hospitals; and (2) ten equal sized strata (each decile of the distribution of hospitals by DSH Index).

The baseline ERRs were then standardized within each strata. The standardized ERRs had a mean of 1.00 and a standard deviation equal to the standard deviation of ERRs across all hospitals for that condition. Finally, penalties were evaluated using the stratified, standardized ERRs and the FY 2013 IPPS penalty formulas.

3. Rewarding Improvement

Details on the methodology for rewarding improvement are included in the main text of Chapter 5.

4. Moving to a Hospital-Wide Readmissions Measure

Hospital-wide readmissions were based on the 2014 hospital-wide readmission measure update available at https://www.qualitynet.org using FY 2013 Medicare FFS claims. The hospital-wide readmission measure is based on a single Standardized Risk Ratio (SRR) rather than the five condition-specific ERRs currently used in the HRRP. HRRP penalties were simulated using the FY 2013 penalty formulas with the hospital-wide SRR as described below.

Budget neutrality was defined as preserving the total value of penalties across all hospitals, and each hospital's penalty under the simulated option was reduced by the same percentage to achieve budget neutrality. The mean penalty across hospitals might change under a budget neutral option due to a different number of hospitals included in the hospital-wide readmission measure as compared to the condition specific measures.

II. Calculating Penalties under the Hospital Readmissions Reduction Program

A. The Current Hospital Readmissions Reduction Program

The current HRRP penalizes hospitals with higher than expected readmission rates on one or more of five target conditions, up to 3% of their base DRG payments. The HRRP was established under the Affordable Care Act (ACA), and is described and modified annually through CMS' IPPS rule.

The computation of a hospital's penalty under this program is complex, and involves the following steps:

1. Calculation of **risk-standardized readmissions** for each of the five conditions
2. Calculation of the hospital's **excess readmission ratio (ERR)** for each of the five conditions
3. Calculation of the hospital's **aggregate payments for excess readmissions** across all five conditions
4. Calculation of the hospital's **ratio** of payments for excess readmissions to total payments
5. Calculation of a hospital's **readmissions adjustment factor (RAF)**

1. Risk-standardized readmissions

Index admissions for each of the five target conditions (AMI, heart failure, pneumonia, COPD, and total hip/knee replacement), are defined by condition-specific inclusion and exclusion criteria. *Readmissions* are defined as any unplanned readmission within 30 days of hospital discharge from an index admission.

Hospital level risk-standardized readmissions are used. These are risk adjusted for patients' age, sex, and medical comorbidities using all Medicare claims from the previous year. The *risk standardized readmissions* are derived from a hierarchical logistic model estimating a patient's probability of admission as a function of the risk adjustment variables and a hospital specific intercept.

2. Excess Readmission Ratio

The hospital specific e*xcess readmission ratio (ERR)* for each condition is derived from the risk standardized readmissions and defined as predicted readmissions divided by expected readmissions. *Predicted readmissions* are the number of readmissions at a specific hospital predicted by the standardized readmission model. *Expected readmissions* are the number of readmissions predicted for an average hospital with that specific hospital's case mix (i.e. the predicted value excluding the hospital specific intercept).

$$ERR = \frac{risk-standardized\ predicted\ readmissions}{risk-standardized\ expected\ readmissions}$$

ERRs greater than 1 indicate that a hospital is performing worse than average given its case mix, while ERRs less than 1 show that a hospital is performing better than average.

ERRs are generated using 3 years of data with a two year lag, so HRRP penalties during FY 2015 are based on admissions from June 2010-June 2013. A hospital must have at least 25 index admissions during this time to have an ERR reported for a condition.

Example:

If a hospital were performing better than average on 2 conditions (pneumonia and hip/knee replacement) but worse than average on 3 conditions (AMI, heart failure, and COPD), they could have the ERRs below:

Appendix Table 5.2. Example Excess Readmission Ratios (ERRs)

Condition	ERR	Number of Index Admissions
AMI	1.03	175
Pneumonia	0.98	275
Heart failure	1.07	400
COPD	1.04	300
Hip/knee replacement	0.97	200

3. Payments for Excess Readmissions

The readmission penalty is based on the ratio of payments for excess readmissions to all payments. For conditions with ERRs less than or equal to 1, there are no excess readmissions and thus no payments for excess readmissions. For conditions with ERRs greater than 1, *payments for excess readmissions* are defined as the sum of base operating diagnostic related group (DRG) payments for index admissions, multiplied by the condition's ERR-1. The *base operating DRG* is adjusted only for geographic factors and new technology add-on payments.

$$Aggregate\ payments\ for\ excess\ readmissions = \sum_{i=1}^{5} [(Base\ operating\ DRG\ payment)_i * (ERR_i - 1)]$$

$For\ condition\ i$

Example

Based on the ERRs reported above, the aggregate payments for excess readmissions are calculated below:

Appendix Table 5.3. Example Sum of Condition Base Operating Diagnosis Related Groups (DRG) Payments

Condition	ERR	Number of Index Admissions	Base Operating DRG Payments	Payment for Excess Readmissions
AMI	1.03	175	$2,200,000	$66,000
Pneumonia	0.98	275	$2,000,000	$0
Heart failure	1.07	400	$3,100,000	$217,000
COPD	1.04	300	$2,800,000	$112,000
Hip/knee replacement	0.97	200	$2,500,000	$0
Aggregate				**$395,000**

4. Ratio

A hospital's *ratio* is the aggregate payments for excess readmissions divided by the aggregate payments for all discharges, subtracted from 1. The *aggregate payments for all discharges* are the base operating DRG payments for all discharges from a hospital during the three year time period.

$$Ratio = 1 - \frac{Aggregate\ payments\ for\ excess\ readmissions}{Aggregate\ payments\ for\ all\ discharges}$$

Example

If the aggregate payments for all discharges were $90 million (over 3 years) and the aggregate payments for excess readmissions were $395,000 (from above), then the hospital's ratio would be:

$$Ratio = 1 - \frac{\$395{,}000}{\$90{,}000{,}000} = 0.9956$$

5. Readmission Adjustment Factor

A hospital's *readmission adjustment factor (RAF)* is the greater of the ratio or 0.97, since the highest penalty that a hospital can receive is 3%. The hospital's future base DRG payments for all admissions are multiplied by the RAF to administer the penalty.

Example

If the hospital's ratio is 0.9956, then 0.9956 > 0.97, so the RAF = 0.9956.

B. Hospital-Wide Readmission Rates

Hospital-wide readmission rates are reported in the Hospital Compare database (https://www.medicare.gov/hospitalcompare), but are not currently included in the HRRP. This section describes how the hospital-wide readmission rate is calculated and the effects if it were to be used with the current HRRP penalty formulas. However, the HRRP penalty formulas based on the hospital-wide readmission measure could differ from the current condition-based formulas.

The computation of a hospital's penalty using Hospital Compare's hospital-wide readmission measure and the current HRRP penalty formulas would involve the following steps:

1. Calculation of **risk standardized readmissions** for each of the five cohorts included in the hospital-wide measure
2. Calculation of the hospital's **standardized risk ratio (SRR)** for each of the five cohorts
3. Calculation of the hospital-wide **SRR**
4. Calculation of the hospital's **aggregate payments for excess readmissions** across all five cohorts
5. Calculation of the hospital's **ratio**
6. Calculation of a hospital's **readmissions adjustment factor (RAF)**

1. Risk standardized readmissions

Index admissions for each of the five mutually exclusive cohorts (medicine, surgery/gynecology, cardiorespiratory, cardiovascular, and neurology), are defined by cohort specific inclusion and exclusion criteria. *Readmissions* are defined as any unplanned readmission within 30 days of hospital discharge from an index admission.

Hospital level risk standardized readmissions are used. These are risk adjusted for patients' age, sex, and comorbidities. As compared to the condition specific measures, cohort risk adjustment uses only inpatient claims from the previous year. Risk adjustment variables for the hospital-wide measure are in Appendix 2. The *risk standardized readmissions* are derived from a hierarchical logistic model estimating a patient's probability of admission as a function of the risk adjustment variables and a hospital specific intercept.

2. Cohort Standardized Readmission Ratios

The hospital specific *standardized readmission ratio (SRR)* for each cohort is analogous to the ERR in the condition specific measure, but uses a different time period for index admissions. This is derived from the risk standardized readmissions and defined as predicted readmissions divided by expected readmissions. *Predicted readmissions* are the number of readmissions predicted by the standardized readmission model. *Expected readmissions* are the number of readmissions predicted for an average hospital with a specific hospital's case mix (i.e. the predicted value excluding the hospital specific intercept). SRRs greater than 1 indicate that a hospital is performing worse than average given its case mix, while SRRs less than 1 show that a hospital is performing better than average.

Cohort SRRs are generated using a 1 year of data, as opposed to the 3 years of data needed for condition specific ERRs. A hospital must have at least 25 index admissions during the year to have the cohort included in the calculation of the hospital-wide readmission measure.

$$SRR = \frac{risk - standardized\ predicted\ readmissions}{risk - standardized\ expected\ readmissions}$$

Example

The hospital-wide readmission example provides a comparison to the condition specific calculation by using SRRs that are equivalent to the ERRs in the condition specific example. However, the number of index admissions and the aggregate payments are reflective of a typical hospital's annual volume and thus differ between the two examples.

Appendix Table 5.4. Example Cohort Standardized Readmission Ratios (SRRs)

Cohort	SRR	Number of Index Admissions
Medicine	1.03	700
Surgery/gynecology	0.98	500
Cardiorespiratory	1.07	250
Cardiovascular	1.04	100
Neurology	0.97	60

3. Hospital-wide Standardized Readmission Ratio

The five cohorts are combined to create a single hospital-wide SRR. The *hospital-wide SRR* is the volume weighted logarithmic mean of the SRRs for each cohort. Cohorts with less than 25 index admissions over the year are excluded from the calculation of the hospital-wide SRR.

$$Hospital\ wide\ SRR = exp\left(\frac{\sum_{j=1}^{5} n_j * \log(SRR_j)}{\sum_{j=1}^{5} n_j}\right)$$

$$For\ cohort\ j\ with\ n_j\ index\ admissions$$

Example

Based on the SRRs reported above, the hospital-wide SRR is calculated below.

Appendix Table 5.5. Example Hospital-Wide Standardized Readmission Ratio (SRR)

Cohort	SRR	log(SRR)	Number of Index Admissions
Medicine	1.03	0.03	700
Surgery/gynecology	0.98	-0.02	500
Cardiorespiratory	1.07	0.07	250
Cardiovascular	1.04	0.04	100

Neurology	0.97	-0.03	60

$$Hospital - wide\ SRR = \ exp\left(\frac{(0.03*700)+(-0.02*500)+(0.07*250)+(0.04*100)+(-0.03*60)}{700+500+250+100+60}\right) = 1.018$$

4. Payments for Excess Readmissions

There is currently no penalty based on the hospital-wide readmission measure. For this reason, the same formulas as the current HRRP penalty based on condition specific ERRs are used in this analysis; however, when implementing a hospital-wide readmission penalty, an alternate method would be possible.

The current HRRP penalty is based on the ratio of payments for excess readmissions to all payments. For hospitals with a hospital-wide SRR less than or equal to 1, there are no excess readmissions and thus no payments for excess readmissions. For hospitals with a hospital-wide SRR greater than 1, *payments for excess readmissions* are currently defined as the sum of base operating diagnostic related group (DRG) payments for index admissions, multiplied by the SRR-1. The *base operating DRG* is adjusted only for geographic factors and new technology add-on payments.

$$Aggregate\ payments\ for\ excess\ readmissions = (SRR - 1) * \sum_{j=1}^{5} (Base\ operating\ DRG\ payments)_j$$

$For\ cohort\ j$

Example

Based on the number of index admissions above, the aggregate payments for excess readmissions are calculated below:

Appendix Table 5.6. Example Sum of Cohort Base Operating Diagnosis Related Groups (DRG) Payments

Cohort	Number of Index Admissions	Base Operating DRG Payments
Medicine	700	$5,500,000
Surgery/gynecology	500	$7,000,000
Cardiorespiratory	250	$1,800,000
Cardiovascular	100	$700,000
Neurology	60	$500,000
Sum		**$15,500,000**

For a hospital with a hospital-wide SRR of 1.018

$$Aggregate\ payments\ for\ excess\ readmissions = (1.018 - 1) * \$15{,}500{,}000 = \$279{,}000$$

5. Ratio

A hospital's *ratio* under the current HRRP is the aggregate payments for excess readmissions divided by the aggregate payments for all discharges, subtracted from 1. The *aggregate payments for all discharges* are the base operating DRG payments for all discharges from a hospital during the year.

$$Ratio = 1 - \frac{Aggregate\ Payments\ for\ Excess\ Readmissions}{Aggregate\ Payments\ for\ All\ Discharges}$$

Example

If the aggregate payments for all discharges were $30 million and the aggregate payments for excess readmissions were $279,000 (from above), then the hospital's ratio would be:

$$Ratio = 1 - \frac{\$279{,}000}{\$30{,}000{,}000} = 0.9907$$

6. Readmission Adjustment Factor

A hospital's *readmission adjustment factor (RAF)* is the greater of the ratio or 0.97, since the greatest penalty that a hospital can receive is 3%. The hospital's future base DRG payments are multiplied by the RAF to administer the penalty.

Example

If the hospital's ratio is 0.9907, then 0.9907 > 0.97, so the RAF = 0.9907.

III. Appendix Tables and Figures

Appendix Table 5.7. Odds Ratio for Readmission for Black Patients

	Black Alone	Black, Adjusting for Comorbidities	Black, Adjusting for Comorbidities and Other SES Variables*
Acute MI	**1.18**	**1.13**	1.01
Heart Failure	**1.12**	**1.09**	1.01
Pneumonia	**1.36**	**1.20**	**1.13**
THA/TKA	**1.25**	1.13	0.98
COPD	**1.41**	**1.20**	**1.09**

MI=myocardial infarction; THA=total hip arthroplasty; TKA=total knee arthroplasty; COPD=chronic obstructive pulmonary disease. *Model includes hospital random effects, and includes the HRRP risk adjustment variables (age, gender, medical comorbidities); beneficiary social risk factors (dual status, disability, urban, self-reported race); ZIP code variables (income, education, racial composition, English language proficiency, marital status, employment rate, poverty rate, median home value), and other hospital characteristics (teaching, margin, member of a system, size, urban, and ownership). Bolded/shaded odds are significant at p<0.05.

Appendix Table 5.8. Odds Ratio for Readmission for Hispanic Patients

	Hispanic Alone	Hispanic, Adjusting for Comorbidities	Hispanic, Adjusting for Comorbidities and Other SES Variables*
Acute MI	**1.25**	1.09	0.98
Heart Failure	**1.10**	1.04	0.96
Pneumonia	**1.07**	1.04	1.01
THA/TKA	1.13	1.06	0.88
COPD	**1.28**	**1.17**	1.07

MI=myocardial infarction; THA=total hip arthroplasty; TKA=total knee arthroplasty; COPD=chronic obstructive pulmonary disease. Models include a hospital random effect. *Model includes the HRRP risk adjustment (age, gender, medical comorbidities); beneficiary measures (rurality, self-reported race; and ZIP code variables (income, education, racial composition, English language proficiency, marital status, employment rate, poverty rate, median home value). Bolded/shaded odds are significant at p<0.05.

Appendix Table 5.9. Odds Ratio for Readmission for Urban Patients

	Urban Alone	Urban, Adjusting for Comorbidities	Urban, Adjusting for Comorbidities and Other SES Variables*
Acute MI	**1.12**	**1.10**	**1.10**
Heart Failure	**1.05**	**1.04**	**1.05**
Pneumonia	1.02	1.00	1.02
THA/TKA	**1.08**	**1.08**	**1.06**
COPD	**1.09**	**1.06**	**1.05**

MI=myocardial infarction; THA=total hip arthroplasty; TKA=total knee arthroplasty; COPD=chronic obstructive pulmonary disease. Models include a hospital random effect. *Model includes the HRRP risk adjustment (age, gender, medical comorbidities); beneficiary measures (rurality, self-reported race; and ZIP code variables (income, education, racial composition, English language proficiency, marital status, employment rate, poverty rate, median home value). Bolded/shaded odds are significant at p<0.05.

Appendix Table 5.10. Change in Odds of Readmission for Patients with a $1000 Increase in Zip Code Median Income

	Low-Income ZIP Alone	Low-Income ZIP, Adjusting for Comorbidities	Low-Income ZIP, Adjusting for Comorbidities and Other SES Variables*
Acute MI	**0.99**	**0.99**	1.00
Heart Failure	**<1.00**	**<1.00**	1.00
Pneumonia	**<1.00**	**<1.00**	**>1.00**
THA/TKA	**<1.00**	1.00	**1.01**
COPD	**0.99**	**<1.00**	**>1.00**

MI=myocardial infarction; THA=total hip arthroplasty; TKA=total knee arthroplasty; COPD=chronic obstructive pulmonary disease. Models include a hospital random effect. *Model includes the HRRP risk adjustment (age, gender, medical comorbidities); beneficiary measures (rurality, self-reported race; and ZIP code variables (income, education, racial composition, English language proficiency, marital status, employment rate, poverty rate, median home value). Bolded/shaded odds are significant at p<0.05.

Appendix Table 5.11. Results of Adjusting Readmission Rates for Social Risk Factors

	Current Penalty			New Penalty (adjusted for dual status, rurality, ZIP Code Per-Capita Median Income, and ZIP Code Average Education Attained)		
	% of Hospitals Penalized	Penalty in Thousands of $	Penalty as % of base DRG payment	% of Hospitals Penalized	Penalty in Thousands of $	Penalty as % of Base DRG payment
All Hospitals	82%	$158	0.46%	82%	$147	0.42%
SNH (top 20% of DSH)	88%	$191	0.48%	85%	$151	0.38%
Non-SNH (all other)	80%	$150	0.45%	81%	$146	0.43%

Appendix Table 5.12. Results of Stratification by DSH Index

	Current Penalty			New Penalty (after stratifying hospitals into deciles)		
	% of Hospitals Penalized	Penalty in Thousands of $	Penalty as % of Base DRG Payment	% of Hospitals Penalized	Penalty in Thousands of $	Penalty as % of Base DRG Payment
All Hospitals	82%	$158	0.46%	82%	$160	0.47%
SNH (top 20% of DSH)	88%	$191	0.48%	77%	$144	0.34%
Non-SNH (all other)	80%	$150	0.45%	83%	$164	0.51%

Appendix Table 5.13. Results of Rewarding Improvement

	Current Penalty			New Penalty (after applying an improvement bonus multiplied by DSH Index)		
	% of Hospitals Penalized	Penalty in Thousands of $	Penalty as % of Base DRG Payment	% of Hospitals Penalized	Penalty in Thousands of $	Penalty as % of Base DRG Payment
All Hospitals	82%	$158	0.46%	82%	$150	0.43%
SNH (top 20% of DSH)	88%	$191	0.48%	88%	$182	0.45%
Non-SNH (all other)	80%	$150	0.45%	80%	$143	0.43%

Appendix Chapter 6: The Hospital-Acquired Conditions Reduction Program

The Supplemental Materials provide additional, detailed information on the program, measures, analytic methods used, and analysis results to supplement the main report chapter findings.

A. HACRP Program Background

The Hospital Acquired Conditions Reduction program was established under section 3008 of the 2010 Patient Protection and Affordable Care Act (ACA), starting in FY 2015 (October 1, 2014). The HACR program requires the Secretary of the Department of Health and Human Services to adjust payments to applicable hospitals that rank in the worst performing quartile of all subsection (d) hospitals based on risk-adjustment patient safety measures.
Program details are available here: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/HAC-Reduction-Program.html

Penalty Calculation
Hospitals in the worst performing quartile have their total payments under the Inpatient Prospective System (IPPS) reduced by 1 percent than would have otherwise been paid to the hospital, which includes payments for disproportionate share hospitals (DSH) and graduate medical education (IME). These payments are intended to offset the additional costs incurred by safety-net and teaching hospitals to provide care to low-income Medicare beneficiaries receiving Medicaid or Supplemental Social Security Income (SSI), or to teach doctors-in-training, i.e. medical residents.

This is a distinctly different approach to calculating payments than the two other hospital payment programs, Hospital Readmissions Reduction program (HRRP) and the Hospital Value-based Purchasing (HVBP) which both determine adjustment to payments (i.e. penalties and bonuses) using base diagnostic related group (DRG) payments. Base DRG payments are equivalent for patients in the same MS-DRG category; these categories classify patients by condition and severity of illness. Hospitals with a higher patient case-mix are therefore paid more for treating higher severity patients.

Scoring Methodology
In the FY2014 IPPS/LTCH PPS Final Rule, CMS defined the measures comprising the HAC Reduction program and the scoring methodology. It identifies the worst performing quartile (25%) of hospitals by calculating a Total HAC Score composed of two domains, patient safety (Domain 1) and healthcare associated infections (Domain 2). The scores for each domain are weighted and combined to form the Total HAC Score. Domain weights started at 35% for Domain 1 and 65% for Domain 2 in FY 2015, and increase by 10% for Domain 2 in subsequent years. (See Table below for domain weights in each program year). Domain 1 includes 1 composite measure while Domain 2 started with 2 measures, with

additional measures added over time. Based on the number of measures in Domain 2, the weight per measure is also estimated to show how much each measure contributes to the Total HAC Score. More detailed information on scoring is available on the QualityNet website (https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1228774298601).

Appendix Table 6.1: HACRP Domain Weights by Program Year

Domain Weights	HAC Reduction Program – Payment Year				
	FY15	**FY16**	**FY17**	**FY18 (TBD)**	**FY19 (TBD)**
Domain 1 (PSI-90 composite)	35%	25%	15%	15%	TBD
Domain 2 (CDC measures)	65%	75%	85%	85%	TBD
- number of measures	2	3	5	5	TBD
- weight per measure	33%	25%	17%	17%	TBD

Hospitals are assigned a measure score from 1 to 10 to reflect the hospital's relative rank in 10 groups (i.e. deciles). If there are multiple measures within a domain, the scores are averaged (simple average) to calculate the domain score. The sum of the weighted domain scores is calculated for the Total HAC Score. Higher score indicate worse performance relative to other hospitals. Hospitals with a Total HAC Score greater than the 75th percentile are subject to the HAC Reduction payment reduction (penalty).

Measures

For the HAC Reduction program, Domain 1 includes AHRQ's Patient Safety Indicator Composite measure (PSI-90) that includes 8 components; Domain 2 includes the CDC's healthcare-associated infection measures. More detailed information on the measures is available from QualityNet website (https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1228774298601).

Appendix Table 6.2: HAC Reduction Program – Domains and Measures

HAC Reduction Program	Description	Measure
Domain 1	AHRQ: Patient Safety	PSI-90 Composite *(own weighting scheme applied to 8 components)*
Domain 2	CDC: Healthcare associated infection measures (average of measure scores)	• CLABSI, CAUTI (FY15), • SSI (FY16 added), • MRSA, C. Difficile (FY17 added)
Total HAC Score	Sum of weighted domain scores	

AHRQ's PSI-90 Composite measure: The PSI-90 includes eight PSIs which are each separately risk-adjusted (with their own set of risk-adjustment clinical covariates) and then combined using a weighted average of the risk-adjusted and reliability-adjusted (smoothed) versions.

The PSI-90 method for reliability-adjustment accounts for the lack of reliability due to hospital's size by also partly weighting the national rate into the hospital's final rate, with weights determined by hospital size. The rates for smaller hospitals are weighted more heavily towards the national rate to account for the lack of reliability, while larger hospitals have their own rate count more. See detailed methodology in CMS and AHRQ specifications on the composite methodology.

As a composite measure, the PSI-90 also uses its own weighting scheme to combine the eight components into a composite rate. This weighting is based on the numerator volume of each component, so that components with more patient safety events count more towards the final composite rate.

However the current weighting scheme does not account for differences in potential severity of harms from the various components. Recently NQF endorsed AHRQ's revised version of the PSI-90 measure (version 6, also known as "modified PSI-90") which incorporates harms as well as numerator volume, so that components that inflict the most harms and are relatively more frequent are weighted the most. In addition, the Modified PSI-90 will include 3 new components, PSI-8, PSI-9, and PSI-10 and the NQF-endorsed version removed PSI-7 to avoid duplication with the CDC's version of the CLABSI measure. Another version retains PSI-7 for use by hospitals for quality improvement purposes.

The preliminary modified weights are shown in the report; these weights will later be updated (by December, 2016) using more recent data and also updated using ICD-10 codes to reflect more recent estimates of harms and volume of cases. CMS has indicated it will plan to use the modified PSI-90 starting in FY 2018.

CDC's healthcare associated infection measures: The infection measures are chart-abstracted surveillance data (i.e. laboratory confirmed infections) reported by hospitals to the National Healthcare Safety Network (NHSN), primarily for public health surveillance. These measures are calculated as standardized infection ratios (SIR), which are ratios of observed-to-predicted number of infections determined against a national baseline rate. A SIR greater than 1 indicates a hospital is performing worse (more infections) than the national average in the baseline period.

In FY2015, Domain 2 started with 2 CDC healthcare associated infection measures - central-line associated blood stream infections (CLABSI) and catheter-associated urinary tract infections (CAUTI). In FY2016, the program also includes CDC's measure of Surgical Site Infections (combining surgeries for colon and hysterectomies). In FY 2017, MRSA and Clostridium Difficile infection measures will be added to Domain 2.

From FY 2015 to FY 2017, CLABSI and CAUTI measures only include patients in selected intensive care units (ICU) and are risk-adjusted at the hospital-level and patient-care unit level such as teaching status. Starting in FY 2018, CMS will adopt a revised version of the measures which expands the measure to non-ICU locations including medical and surgical wards. For SSI, MRSA and C. Difficile infection healthcare associated infection measures, these are risk-adjusted at the patient-level and are not restricted to ICUs.

Minimum reporting requirements:
CMS applies minimum reporting requirements to the AHRQ PSI-90 and CDC infections measures to ensure measurement reliability. This affects whether a hospital has a reported rate for the measure to be included in the program. Domain and measure scores are only calculated on measures where there is a valid rate reported that meet the minimum reporting requirements. Domain weights are redistributed if only 1 domain score is reported.

For AHRQ's PSI-90 measure, if there are fewer than 3 eligible discharges in the denominator for one of the eight components, the hospital's rate is substituted with the national rate, (i.e. there is insufficient information from the hospital data to accurately calculate a rate).

For the CDC measures, the CDC has determined a minimum of 1 predicted infection is required to calculate a standardized infection ratio for the measure. Small hospitals are less likely to have at least 1 infection predicted based on the prediction model.

Changes to Measures and Program Scoring Methodology
Table below shows the individual measures included in each program year, the respective measurement periods, and changes/updates to measures. In addition, the table summarizes changes to program scoring rules, including proposed changes that are not yet finalized for FY18 and FY19.

Appendix Table 6.3: Expected Changes to HACRP Measures and Program by Program Year

HACRP Program Elements		HAC Reduction Program – Payment Year				
	Patient Safety Measures	**FY15**	**FY16**	**FY17**	**FY18** (Proposed)	**FY19** (Proposed)
Scoring Rules		Decile scores	Decile scores	Decile scores	Winsorized Z-scores†	Winsorized Z-scores†
Domain 1	Patient Safety Indicator Composite (PSI-90)	X v4.5	X v5	X	X* Modified PSI-90	X* Modified PSI-90
Performance period		2011-2013	7/2012 - 6/2014	7/2013-6/2015		
Min reporting requirements		3 eligible discharges, 8 components				
Domain 2	Central-line associated blood stream infections (CLABSI)	X ICU only	X ICU only	X ICU only	X** Non-ICU	X** Non-ICU
	Catheter-associated urinary tract infections (CAUTI)	X ICU only	X ICU only	X ICU only	X** Non-ICU	X** Non-ICU
	Surgical Site Infections (SSI) (colon & hysterectomy)		X	X	X	X
	Methicillin-resistant Staphylococcus (MRSA) bacteremia			X	X	X

	Clostridium Difficile (C. Diff, CDI)			X	X	X
	Future measures – antibiotic use? (TBD)					
Performance period		CY2012-2013	CY2013-2014	CY2014-2015	CY2015-2016 ***Revised CDC benchmarks	CY2016-2017 ***Revised CDC benchmarks
Min. reporting requirements		1 predicted infection				

* Modified PSI-90: harms-weighted with 3 additional PSIs: PSI-9, 10, 11
** In FY18 and beyond, CLABSI and CAUTI measures will be expanded to include non-ICU locations, as previously indicated; current (FY16 and earlier) and prior versions were restricted to ICU wards only
***Starting FY18, all CDC measures will use the updated CDC 2015 benchmark to calculate standardized infection ratios (SIR)
†Starting FY18, CMS proposes to use winsorized z-scores instead of decile-based scores to score hospital's performance on measures to address issue of ties in performance that resulted in some hospitals with zero events falling into the penalty range.

B. Detailed Methods

1. Patient social risk and related risk factors

Medicare beneficiaries' social risk factors were identified from various sources. Using Medicare enrollment data, patients' social risk factors were identified, including Blacks and Hispanics recoded from Medicare enrollment data by RTI, dually eligible for Medicaid and Medicare (including full and partially eligible for dual benefits), disability based on the original reason for Medicare entitlement. Census data was also used to identify patients residing in low-income neighborhoods with the lowest median household income at the Zip code tabulation area (ZCTA) and patients from rural areas defined as a non-Metropolitan Statistical Area (MSA).

In addition, patients' with high medical risk or medical complexity were identified based on the highest quintile of HCC scores from a prior year of Medicare claims data in the RAPS file. HCC scores are used for Medicare Advantage risk-adjustment. The table below identifies the patient social risk factors and the relevant data sources used in these regression analyses.

In addition to the above social risk factors used across the hospital programs, an additional related factor for medical complexity was identified using Hierarchical Condition Category (HCC) risk scores calculated by CMS on each Medicare beneficiary to estimate their medical risk and potential unmeasured medical complexity. Disability as the original reason for Medicare entitlement was also identified from Medicare Enrollment Database to identify beneficiaries who were young and disabled at the time they enrolled in Medicare.

Table below describes how each social and related risk factor was identified from Medicare data and defined for this study.

Appendix Table 6.4: Definitions of Medicare beneficiary social and related risk factors used in this study (HACRP)

Beneficiary Social Risk	Data Sources	Definition
Dual Eligible	Enrollment Database	Beneficiary was eligible for both Medicare and Medicaid in the three months before admission date, month of admission date, or three months after admission date.

		If the DUAL_MDCR variable is part of the list below , the beneficiary is deemed dual eligible: • 01 = Eligible is entitled to Medicare- QMB only • 02 = Eligible is entitled to Medicare- QMB AND Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) • 03 = Eligible is entitled to Medicare- SLMB only • 04 = Eligible is entitled to Medicare- SLMB AND Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) • 05 = Eligible is entitled to Medicare- QDWI • 06 = Eligible is entitled to Medicare- Qualifying individuals • 07 = Missing in latest data dictionary and shows up rarely (<.001%); consulting with analogous MAX variable suggested that this is the same as 06 • 08 = Eligible is entitled to Medicare- Other Full Dual Eligibles (Non QMB, SLMB,QWDI or QI)with Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) • 09 = Eligible is entitled to Medicare – Other Dual Eligibles but without Medicaid coverage, includes Pharmacy Plus and 1115 drug-only demonstration.
Low-Income	Enrollment Database 5-year ACS estimates UDS Mapper Zip to ZCTA crosswalk (2014)	All ZIP Code Tabulation Areas (ZCTAs) were ranked based on their American Community Survey (ACS) 5-year estimates of median household income. A cut-off for the lowest quintile of ZCTA-level income was determined using these rankings. ZCTAs that had a median household income below the cut-off were “low-income.” The beneficiary’s most recent zip code of residency before the admission date was used to determine which zip code and corresponding ZCTA to assign to a stay. Any stay that was assigned a “low-income” ZCTA was then flagged as a “low-income” stay.
Black	Master Beneficiary Summary File	Beneficiary has RTI race code= 2 “Black (or African-American)”
Hispanic	Master Beneficiary Summary File	Beneficiary has RTI race code= 5 “Hispanic”
Rural	Enrollment Database	The beneficiary’s most recent county and state of residency before the admission date was used to determine if they resided in a Metropolitan Statistical Area (MSA). Any stay that was non-MSA was considered “rural.”
Disabled	Enrollment Database	If the beneficiary’s original reason for Medicare entitlement is “disability” then the stay was flagged as “disabled.” Stays with beneficiaries who were entitled to Medicare because of age and who are also disabled were not included in this category.
Medical Complexity/ HCC Risk Quintile	RAPS file	For the PSI-90 analysis in the HACRP program: Each beneficiary’s history of Hierarchical Condition Category scores (HCC)s used for Medicare Advantage risk-adjustment for the calendar year prior to year of inpatient stay admission was used to calculate a clinical risk score. Stays were then split into risk quintiles based on these scores, and the highest quintile was flagged for “Medical Complexity.”

Medical Complexity (Highest Risk Quintile)	MSPB measure	For the MSPB analysis in the HVBP program: Each beneficiary's HCCs used in the risk-adjustment of the Medicare Spending per Beneficiary measure, based on a 90-day look back period from the index hospitalization. Stays were then split into risk quintiles based on these scores, and the highest quintile was flagged for "Medical Complexity."

- **Hospital social risk & related risk factors**
  Using Medicare enrollment data to identify patient characteristics, hospitals were classified based on the top quintile share of the social or related risk factor of interest. The table below shows the definitions of the provider characteristics by the proportion of patients with the social risk factor of interest; these were determined outside of any specific measure used for HACRP. Unless otherwise indicated, they were determined based on hospitals that qualify for the Hospital Readmission Reduction Program (HRRP), and proportions of index admissions with the social risk factor of interest.

  To identify hospitals who predominantly serve socially at-risk Medicare beneficiaries, hospitals with the top 20% share of beneficiaries with the social or related risk factor were identified, i.e. high share of duals, SSI, DSH, disabled, Blacks, Hispanics, low-income ZCTA patients. Hospitals located in non Metropolitan Statistical Areas (MSA) were defined as rural since that is how they are defined for Medicare payment purposes.

  In addition to social risk, for the HACRP program analyses, hospitals with a high proportion of medically complex patients, a hospital's average patient case mix index and average HCC risk scores based on patient stays in 2013.

Appendix Table 6.5: Provider Level Measures of Social Risk

Provider Social & Related Risk	Data Source	Definition
High Dual	Stay-level beneficiary dual flag from HRRP stays	Provider had top 20% highest proportion of "Dual" stays in observation period
High Low-Income	Stay-level beneficiary low-income flag from HRRP stays	Provider had top 20% highest proportion of "Low-Income" stays in observation period
High Black	Stay-level beneficiary Black flag from HRRP stays	Provider had top 20% highest proportion of "Black" stays in observation period
High Hispanic	Stay-level beneficiary Hispanic flag from HRRP stays	Provider had top 20% highest proportion of "Hispanic" stays in observation period
Rural	CASPER	Provider is located in non-MSA
High Disabled	Stay-level beneficiary disabled flag from HRRP stays	Provider had top 20% highest proportion of "Disabled" stays in observation period
High Medical Complexity	Stay-level beneficiary Medical Complexity flag from PSI-90 eligible stays, RAPS file	Provider had top 20% highest proportion of "Medical Complexity" stays eligible for PSI-90 composite measure
DSH Index - DSH top 20%	Hospital Cost Report (2012)	Disproportionate Share Index; Flag for providers with top 20% highest DSH index
SSI top 20%	Hospital Cost Report (2012)	Provider has top 20% highest Supplemental Social Security Income (SSI)
Patient Case Mix	CMS IMPACT File (FY 2015)	Corrected file, transfer adjusted patient case-mix index

Index (CMI)		reported for each hospital
Average HCC Risk Score	RAPS file, IP claims data (2013)	The average Hierarchical Condition Category (HCC) risk score for all inpatient stays for provider in calendar year 2013. Risk score for the inpatient stays were calculated using 2012 HCC flags, which can be found in the RAPS file. (These were developed for use in Medicare Advantage risk-adjustment).

2. Estimating SES effects using GEE and RE models (general description, see chapter on Methods)

In general for all the patient-level analyses, generalized estimating equation (GEE) and random effects regression models were used to estimate the total and within-hospital effect of patient social risk on measure outcomes. Models included both patient social risk and hospital social risk, separately and together, to assess if observed hospital effects may be reduced after adjusting for patient's social risk.

3. Calculation of PSI-90 measure using Medicare claims

For HACRP, PSI-90 patient safety composite measure is the only Medicare claims-based measure that can be used for patient-level analyses to examine the relationships between patient social risk and measure outcomes. The measure is developed by the Agency for Healthcare Research and Quality and the measure specifications including the specific risk-adjustment variables for each of the 8 components can be found at http://www.qualityindicators.ahrq.gov/modules/PSI_TechSpec.aspx The specific methods for calculating the PSI-90 measure and specific analyses are described in more detail below.

3.1 PSI-90 measure description

- **Step 1:** Create a stay-level analytical file based on Medicare acute care FFS discharges from July 1, 2011 through June 30, 2013, and attach beneficial characteristics from EDB file.
- Detailed inclusion/exclusion criteria can be found here: "2014 Instruction for Replication AHRQ Measure Results Provided in Hospital-Specific Reports," (i.e. Replication Guide)
- **Step 2:** Use version 4.5a of the AHRQ measure software downloaded from AHRQ website, and revise according to the Replication Guide, for example:
- Revise the AHRQ software to account for changes made by CMS – use the calculated Medicare FFS ratio (observed rate/expected rate) instead of national ratio based on the Healthcare Cost and Utilization Project (HCUP) reference population.
- **Step 3:** Run revised software program PSSAS1.SAS, with the analytical file from step 1 as input. This program assigns patient safety indicator, and comorbidities used in risk adjustment. The output of this step is then used in patient-level analysis regressions.
- **Step 4:** Run software program PSSASP2.SAS to calculate observed provider rates for each patient safety indicator.
- **Step 5:** Run revised software program PSSASP3.SAS to calculate risk-adjusted, smoothed, and expected provider rates and merge with observed provider rates. The output of this step is then used in hospital-level analysis, and calculating PSI composite value.
- **Step 6:** Run revised software program PSI_COMPOSITE.SAS, and use the output from step 5 as input. This program creates provider level PSI composite.

3.2 Calculation of PSI-90 measure for patient-level analysis

For the patient-level analysis of the PSI-composite measure, steps 1-3 were replicated for each of the component indicators without using the AHRQ software so that patient-level rates of patient safety events and the effect of social risk for each indicator could be estimated. Since the PSI-90 composite combines the PSI component indicators at the hospital-level, a patient-level analysis of the reported composite rate could not be conducted.

This has implications for how the patient-level results are interpreted. The composite at the hospital-level weights each component based on volume of patient safety events (i.e. numerator), so the final rate reported at the hospital-level may not reflect the social risk effect observed for each component indicator. Therefore it is important to bear in mind the weights for each component, and whether the most heavily-weighted components have a strong effect of social risk. Hospitals with a large proportion of socially at-risk patients may do relatively well on the PSI-90 composite, if the most heavily-weighted components show a weak or negative effect of social risk on patient safety events, as was found for this measure.

Several types of regression models were used to estimate the effect of patient social risk in the patient-level analyses, including logistic, GEE and random effects models. *(See 3.4 for more information about GEE and RE models)*

The following steps describe the patient-level analysis on PSI, based on the file described above.

- Step 1: SES variables described in table 1 and table 2.
- Step 2: Run GEE and RE regressions with and without CMS risk-adjustment
- Step 3: Calculate odds ratios and risk-adjusted rates from regression output

3.3 Calculation of PSI-90 measure for hospital-level analysis

To calculate the PSI-90 composite, CMS uses the Medicare ratio (observed/expected) of the Medicare population. The AHRQ software uses regression results using HCUP as reference population to calculate the expected rate in the Medicare population (i.e. ratio denominator). However without access to the HCUP population, coefficients used to calculate expected rate of the Medicare population could not be recalculated. Instead, an alternate methodology was devised to enable estimating the effect of social risk on patient safety for the hospital-level analysis.

- As an alternative, the PSI-90 composite with social risk is computed with these steps:
    - PSI event = “base log odds” + dual
    - Use AHRQ coefficients to estimate “base logs odds” of PSI event using the current risk adjustment variables
    - Force coefficient on the value of “base log odds” to be 1 (meaning a beta for the variable “base log odds” is not calculated)
    - Estimate coefficient on SES indicator of interest (like dual) with "base log odds" in model

3.4 Estimating effect of social risk from Generalized Estimating Equation (GEE) and Random Effect models for PSI-90

Trends in the odds of a PSI event associated with beneficiary and provider social risk factors were initially explored using logistic regression analysis on each PSI that contributes to the PSI-90 composite.

Generalized estimating equations (GEE) models were used to examine trends across hospitals, while still accounting for within-provider patient correlation, i.e. correlation due to patients going to the same hospital. This is reported as the "Total Effect" of the social risk factor, estimated across hospitals. The SAS procedure that was used to run GEE regressions was Proc GENMOD.

In addition, Random Effect (RE) models using provider-specific random intercepts (i.e. hospital-specific effects) were used to examine the relationship between social risk and measure performance within a hospital. This is reported as the "Within-Hospital Effect" of the social risk factor; with the average within-hospital effect reported in the report tables, and the range of hospital-specific social risk effects shown in the figures. This was achieved using the SAS procedure Proc GLIMMIX.

3.5 Modified PSI-90 (version 6)

The policy simulations estimated the impact of applying harms-based weights to the current PSI-90 measure (version 4.5) since this would change which PSI components are most heavily weighted and therefore whether the composite rate would be influenced by patient social risk.

4. Calculation of the Healthcare Associated Infection (HAI) Measures for hospital-level analyses

From Hospital Compare, annually reported rates reported on all the measures were obtained for measurement year 2013 for SSI, MRSA and C.Diff; for CLABSI and CAUTI both 2012 and 2013 data were used. To replicate the 2-year measurement period used in the HACRP program in FY15, two years data (2012 and 2013) were combined for the CLABSI and CAUTI measures by combining the denominators (predicted cases) and numerators (observed number of infection events) separately. The ratio of the combined observed and predicted cases is taken (numerator/denominator) to obtain the standardized infection ratio for the measure. The steps are laid out below in 4.1.

Since the HAI measure data were only available at the hospital-level, regression models to estimate the effect of a hospital's share of patient social risk (i.e. DSH Index) were run that re-estimate the predicted number of cases adjusting for social risk. To do this, a hospital's predicted number of cases was augmented by the additional number of cases expected based on the hospital's share of social risk, subtracting out the number of cases expected for hospitals with average social risk, so that only the marginal effect of social risk (above or below the average hospital) is added to a hospital's predicted number of cases. This crude method seeks to approximate a patient-level regression, but is limited due to lack of patient-level data. This method was also used in the policy simulations for risk-adjusting the CDC measures by DSH Index or hospitals' average HCC score.

The revised standardized infection ratios are then transformed into measure scores based on decile of performance and combined through a simple average to calculate the Domain 2 score based on the HACRP program methodology. (See 4.3 below). If a measure is missing, the other measure makes up the rest of the Domain 2 score. If both measures in Domain 2 are missing, no Domain 2 score is reported, and the hospital's Total HAC Score is based only on Domain 1 score (i.e. PSI-90 composite measure).

4.1 Method for estimating CDC HAI 2-year measurement period (fiscal year 2015)

An estimate for the 2-year measurement period was calculated for the two Hospital Acquired Infection (HAI) measures (CLABSI and CAUTI) using two sets of one year data from Hospital Compare and the following methods:

- 2-year # of observed cases = 2012 # of observed cases + 2013 # of observed cases
  Set to missing if hospital does not have # of observed cases for both years
- 2-year # of predicted case = 2012 # of predicted cases + 2013 # of predicted cases
  Set to missing if hospital does not have # of predicted cases for both years

- 2-year # of eligible units = 2012 # of eligible units + 2013 # of eligible units
  Set to missing if hospital does not have eligible units for both years
- 2-year SIR = 2-year # of observed cases/2-year # of predicted case
  Set to missing if hospital is missing 2-year # of observed cases or 2-year # of predicted cases
  Set to missing if 2-year # of predicted cases is less than 1

4.2 Method for CDC HAI risk-adjustment

The following steps describe the risk-adjustment methodology measure that uses the 2-year numbers described in the section 3.1.

- Step 1: Calculate an observed rate of infection for each hospital using the observed number of cases/ number of eligible units and an original predicted rate of infection using predicted number of cases/number of eligible units
- Step 2: Run a regression using the model observed rate= β(SES factor) + α
- Step 3: Calculate new predicted rate = original predicted rate + [β * (SES factor - average SES factor for all hospitals)]
    - For cases where two SES factors were included in the risk-adjustment at the same time, the regression in Step 2 was done separately for each SES factor to obtain two different betas which were used in the following equation:
      New predicted rate = original predicted rate + [β_1 * (SES factor$_1$ - average SES factor$_1$ for all hospitals)] + [β_2 * (SES factor$_2$ - average SES factor$_2$ for all hospitals)]
- Step 4: Calculate new predicted number of cases from the new predicted rate
- Step 5: Using the new predicted number of cases, calculate SES risk-adjusted SIR

4.3 Method for calculating CDC HAI score

1. Step 1: Calculate scores (1-10) for each HAI based off of original and newly calculated SIRs.
2. Step 2: Calculate HACR Domain 2 score by taking an average of the CLABSI and CAUTI score. If one of the scores is missing, then the other HAI score is used as the overall HACR Domain 2 score. If both scores are missing, then overall Domain 2 score is set to missing.
3. Step 3: For select report tables to identify if adjusting for social risk would change a hospital's relative ranking, final quartiles were calculated based off of the HACR Domain 2 score, with ties to the lowest quartile.

5. Policy Simulation Methodology

Program Years

Policy options were conducted on non-Maryland hospitals that were included in the fiscal year (FY) 2015 HACR program, using PSI-90 calculated from claims data (see section 2), and CDC HAI calculated from two separate years of hospital compare data (see section 3). FY 2015 weights (Domain 1- 35%, Domain 2-65%) and measures were used. When a provider had one missing Domain score, the other Domain score would receive a weight of 100%.

The improvement options (4 & 5) use FY 2016 weights (Domain 1 – 25%, Domain 2 – 75%) and reported measures to calculate scores displayed in tables and to determine which hospitals are penalized.

Scoring Method

Decile scoring: Hospitals are assigned a decile (1-10) based on PSI-90 composite, which then becomes the Domain 1 score. The Domain 2 score is an average of the SIR deciles (1-10) of all HAI measures included in the program year. Domain weights are then applied to each domain score, and summed to calculate the Total HAC score.

Percentile scoring: Hospitals are assigned a percentile (1-100) based on PSI-90 composite, which then becomes the Domain 1 score. The Domain 2 score is an average of the SIR percentiles (1-100) of all HAI measures included in the program year. Domain weights are then applied to each domain score, and summed to calculate the Total HAC score.

Winsorized z-score scoring: Hospitals are assigned a z-score based on PSI-90 composite, which then becomes the Domain 1 score. An average of the SIR z-scores of all HAI measures included in the program year becomes the Domain 2 score. For each Domain score, any hospital that has a z-score below the 5th percentile of the domain score is assigned a z-score of the 5th percentile, and any hospital that has a z-score above the 95th percentile of domain score is assigned a z-score of the 95th percentile. Domain weights are then applied to each winsorized domain score, and summed to calculate the Total HAC score.

Policy Options Methods

1. **Status Quo: Current HACR Program**
    - FY 2015, Decile scoring- current methodology. This is the reference for comparing the impacts of all the other policy options.

2. **Option: Risk-adjusting for Social Risk**
    - FY 2015, Decile scoring. Several options to risk-adjust individual measures for social risk, either at the patient-level for PSI-90 measure, or hospital-level social risk for CDC healthcare associated infection measures. See Table 3 for SES risk-adjustment combinations

Appendix Table 6.6: SES risk-adjustment combinations

Option	PSI-90 SES Risk-Adjustment	CDC SES Risk-Adjustment
2a	Dual	-
2b	Disabled	-
2c	Dual, Disabled, RTI Black, RTI Hispanic, census-SES*	-
2d	Dual, Disabled, RTI Black, RTI Hispanic, census-SES*	Hospital DSH Index
2e	Medical Complex Patients (top 20% flag)	-
2f	Medical Complex Patients (top 20% flag)	Hospital's Case Mix Index
2g	Medical Complex Patients (top 20% flag)	Average HCC score

*Census based SES characteristics: ZCTA % High School Education, ZCTA Median Home Value, ZCTA % Black, ZCTA % Hispanic, ZCTA Poverty Rate, ZCTA Unemployment Rate, ZCTA Median Household Income

3. **Option: Stratification by DSH Index**

3a) Stratification into two groups. FY 2015, decile scoring.
Hospitals were split into two groups based on their DSH index (top 20% highest DSH index, rest). The 25% worst performing hospitals in each group received a penalty of 1.0% of their IPPS payment.

3b) Stratification into five DSH strata. FY 2015, decile scoring.
Hospitals were split into five groups based on their DSH index quintile. The 25% worst performing hospitals in each quintile received a penalty of 1.0% of their IPPS payment.

Table with DSH Index thresholds used for the two stratification options (pending):

4. **Option: Improvement Buy-Down** (note: average scores are displayed for FY 2016)

Two years of HAC scores were needed to calculate improvement scores. Since FY 2014 HAC data was not available, FY 2016 was used as the performance year, and FY 2015 was used as the baseline year for

determining improvement. For this reason, all penalties and average scores for improvement options were calculated using FY 2016 data.

Winsorized z-score used to calculate improvement from 2015 to 2016.
Hospitals that are penalized in FY 2016, but have an improved (i.e. lower) percentile compared to FY 2015 qualify for an improvement adjustment. This is related to how much the hospital improved compared to the maximum improvement of 24 percentiles. The improvement adjustment is used to buy-down or reduce the amount of the penalty for those hospitals who are penalized in FY 2016, as shown in the formula below. Hospitals who improved maximally from the 100th to the 76th percentile between two years therefore could have their payment adjustment reduced entirely.

Improvement Adjustment = (FY 2015 percentile – FY 2016 percentile) / 24 Option 4 penalty amount = (1- Improvement Adjustment)* 1.0% of IPPS payment amount

For this option only, the impact of the option is compared to the penalty amount that would have applied to hospitals penalized in FY 2016.

5. **Option: Improvement Buy- Down modified by DSH (Note: Average scores displayed are for FY 2016)**

Winsorized z-score used to calculate improvement from 2015 to 2016.
Same as option 4, hospitals that are penalized in FY 2016, but have improved compared to FY 2015 would qualify for an improvement adjustment, but the improvement adjustment would be modified based on the hospital's DSH Index. This gives additional credit for hospitals who disproportionately serve socially at-risk patients. Two options were examined, a)improvement adjustment multiplied by DSH and b) improvement multiplied by 1+truncated DSH. Since the DSH Index can exceed 1 in a few cases, the first approach would only give a few hospitals with very high share of DSH the full credit for improvement while the rest would receive only a portion of the improvement credit. The second approach gives all hospitals the full credit for improvement, plus an additional credit based on their DSH Index which is truncated at 1.

Option 5a) Improvement Adjustment is Multiplied by DSH Index

Penalty amount = (1-(Improvement Adjustment*DSH Index))*1.0% IPPS payment amount

Option 5b) Improvement Adjustment is Multiplied by 1+truncated DSH Index
DSH Index is truncated so that any hospital with DSH index greater than 1 is assigned DSH index =1.

Penalty amount = (1- Improvement Adjustment*(1 + truncated DSH))* 1.0% of IPPS payment amount

6. Option 6: Linear Penalty Scale

6a) FY 2015, decile scoring- Hospitals with top 25% Total HAC score was penalized, but penalty amount was 1.3% of the base DRG amount from the 2012 Cost Report, instead of 1.0% of the IPPS amount.

6b_1) FY 2015, percentile scoring- Hospitals with top 50% Total HAC score was penalized. The hospitals that are penalized are then assigned a percentile (1-100) based on their ranking of Total HAC score among penalized hospitals only.

Option 6b_1 penalty amount= (percentile/100)*2.0% of DRG payment

6b_2) FY 2015, percentile scoring- Hospitals with top 75% Total HAC score was penalized. The hospitals that are penalized are then assigned a percentile (1-100) based on their ranking of Total HAC score among penalized hospitals only.

Option 6b_2 penalty amount= (percentile/100)*1.25% of DRG payment.

7. Option 7: Harms-based Weights

7a) FY 2015, decile scoring- Harms-based weights are used to calculate PSI-90 (see table 4).

Appendix Table 6.7: Harms-based Weighting for PSI-90

PSI-03	PSI-06	PSI-07	PSI-08	PSI-09*	PSI-10*	PSI-11*	PSI-12	PSI-13	PSI-14	PSI-15
0.03574	0.09578	0.01629	0.00864	0.14781	0.04835	0.21193	0.18129	0.23739	0.00875	0.00801

*These PSIs were not included in the original volume-based weights

7a_2) FY 2015, decile scoring- Substitute harms-based weights for PSI, risk-adjust for dual, disabled, RTI Black, RTI Hispanic, ZCTA-level % High School Education, ZCTA-level Median Home Value, ZCTA-level % Black, ZCTA-level % Hispanic, ZCTA-level Poverty Rate, ZCTA-level Unemployment Rate, ZCTA-level Median Household Income

7a_3) FY 2015, decile scoring- Substitute harms-based weights for PSI, split hospitals into top 20% highest DSH and rest. The 25% worst performing hospitals in each group received a penalty of 1.0% of their IPPS payment.

7b) FY 2015, winsorized z-score

7c) FY 2015, winsorized z-score- Substitute harms-based weights for PSI

8. Option 8: Harms-based Weights + Other policy options

8a) FY 2015, winsorized z-score- Substitute harms-based weights for PSI, risk-adjust PSI for dual, risk-adjust CDC HAIs for DSH index

8b_1) FY 2015, winsorized z-score- Substitute harms-based weights for PSI, split hospitals into top 20% highest DSH and rest. The 25% worst performing hospitals in each group received a penalty of 1.0% of their IPPS payment.

8b_2) FY 2015, winsorized z-score- Substitute harms-based weights for PSI, split hospitals DSH quintiles. The 25% worst performing hospitals in each quintile received a penalty of 1.0% of their IPPS payment.

9. Option 9: Winsorized Z-Score + Other policy options

All Option 9 uses FY 2015, winsorized z-score, and substitute harms-based weights for PSI in combination with:

9) Risk-adjust PSI for dual

9a) Risk-adjust PSI for dual, reweight Domain 1-50%, Domain 2-50%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

9b) Risk-adjust PSI for dual, reweight Domain 1-75%, Domain 2-25%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

10. Option 10: Substitute PSI-07 for CLABSI in Domain 2

10a) FY 2015, winsorized z-score- Substitute harms-based weights for PSI, recalculate Domain 2 z-scores by substituting PSI-07 rates for HAI 1 (CLABSI). HAI 2 (CAUTI) was kept the same.

10b) FY 2015, winsorized z-score- Substitute harms-based weights for PSI, risk-adjust PSI for dual, recalculate Domain 2 z-scores by substituting PSI-07 rates for HAI 1 (CLABSI), risk-adjusted for PSI-07 by dual. HAI 2 (CAUTI) was kept the same (no risk-adjustment).

11. Option 11: Winsorized Z-Score + Harms-based Weights + Adjust Domain 2 for HCC risk score + other policy options

All Option 11 uses FY 2015, winsorized z-score- Substitute harms-based weights for PSI in combination with:

11a) Risk-adjust Domain 2 for HCC average risk score

11a_2) Risk-adjust Domain 2 for HCC average risk score, reweight Domain 1-50%, Domain 2-50%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

11a_3) Risk-adjust Domain 2 for HCC average risk score, reweight Domain 1-75%, Domain 2-25%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

11b) Risk-adjust Domain 2 for HCC average risk score and DSH Index

11b_2) Risk-adjust Domain 2 for HCC average risk score and DSH Index, reweight Domain 1-50%, Domain 2-50%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

11b_3) Risk-adjust Domain 2 for HCC average risk score and DSH Index, reweight Domain 1-75%, Domain 2-25%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

12. **Option 12: Winsorized Z-Score + Harms-based Weights + Adjust Domain 2 for HCC risk score + Adjust Domain 1 for dual + other policy options**

All Option 12 uses FY 2015, winsorized z-score- Substitute harms-based weights for PSI, risk-adjust Domain 1 for dual in combination with:

12a) Risk-adjust Domain 2 for HCC average risk score

12a_2) Risk-adjust Domain 2 for HCC average risk score, reweight Domain 1-50%, Domain 2-50%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

12a_3) Risk-adjust Domain 2 for HCC average risk score, reweight Domain 1-75%, Domain 2-25%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

12b) Risk-adjust Domain 2 for HCC average risk score and DSH Index

12b_2) Risk-adjust Domain 2 for HCC average risk score and DSH Index, reweight Domain 1-50%, Domain 2-50%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

12b_3) Risk-adjust Domain 2 for HCC average risk score and DSH Index, reweight Domain 1-75%, Domain 2-25%. If hospital is missing one domain score, the other domain score is reweighted to 100%.

Supplemental Tables

I. Analyses examining relationship between social risk and measure outcomes

1. Relationship between patient social risk and PSI-90 measure components

The relationship between each social risk factors (i.e. Duals, Low-Income ZCTA, Blacks, Hispanics, Rural, Disabled, medically complex patients) are presented below. These tables include the additional PSI components* added to the modified PSI-90, PSI-9, 10, 11 (i.e. version 6).

Appendix Table 6.8: Relationship between beneficiary dual enrollment and PSI-90 measure components

Measure	Unadjusted Odds of Event for Duals	Risk-Adjusted Odds of Event for Duals	Risk-Adjusted, "Within-Hospital" Odds of Event for Duals
PSI-3: Pressure Ulcer	**1.13**	**1.15**	1.06
PSI-6: Iatrogenic Pneumothorax	**0.84**	**0.93**	**0.92**
PSI-7: Catheter-Related BSI	**1.67**	**1.36**	**1.36**
PSI-8: Postop Hip Fracture	1.33	1.32	**1.33**
PSI-9: Postop Hemorrhage or Hematoma Rate*	**1.08**	**1.03***	**1.03***
PSI-10: Postop Physiologic and Metabolic Derangement*	**1.16**	0.96	0.95
PSI-11: Postop Respiratory Failure*	**1.65**	**1.14**	**1.14**
PSI-12: Periop PE or DVT	0.98	**0.91***	**0.91***
PSI-13: Postop Sepsis	**1.30**	**1.18**	**1.17**
PSI-14: Postop Wound Dehiscence	**1.45**	**1.39**	**1.37**
PSI-15: Puncture or Laceration	**0.68**	1.01	0.99

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism.
All bolded/shaded comparisons significant at p<0.05.
1. GEE models; 2. Random effects models.
*Random effects model did not converge due to small numbers for covariates; logistic model was used instead.

a) Zip-level patient income (continuous variable, scaled to $10,000)

Measure	Unadjusted Odds of Event for	Risk-Adjusted Odds of Event for	Risk-Adjusted Within-Hospital Odds of Event for
PSI-3: Pressure Ulcer	1.01	1.00	0.99
PSI-6: Iatrogenic Pneumothorax	1.01	1.00	1.00
PSI-7: Catheter-Related BSI	**0.97**	**0.98**	**0.98**
PSI-8: Postop Hip Fracture	0.96	0.96	0.98
PSI-9: Postop Hemorrhage or Hematoma Rate*	1.00	**1.01**	**1.01**
PSI-10: Postop Physiologic and Metabolic Derangement*	**0.95**	**0.96**	**0.97**
PSI-11: Postop Respiratory Failure*	**0.94**	**0.97**	**0.98**

PSI-12: Periop PE or DVT	**1.03**	1.03	**1.03**
PSI-13: Postop Sepsis	0.99	1.00	1.00
PSI-14: Postop Wound Dehiscence	**0.95**	**0.96**	**0.96**
PSI-15: Puncture or Laceration	1.00	**0.98**	**0.99**

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism. All bolded/shaded comparisons significant at p<0.05.
1. GEE models; 2. Random effects models.
*Model did not converge due to small numbers for covariates; logistic model was used instead.

b) Blacks

Measure	Unadjusted Odds of Event for	Risk-Adjusted Odds of Event for	Risk-Adjusted Within-Hospital Odds of Event for
PSI-3: Pressure Ulcer	**1.18**	1.14	**1.19**
PSI-6: Iatrogenic Pneumothorax	**0.74**	**0.84**	**0.83**
PSI-7: Catheter-Related BSI	**1.92**	**1.68**	**1.59**
PSI-8: Postop Hip Fracture	**0.44**	**0.44**	**0.41**
PSI-9: Postop Hemorrhage or Hematoma Rate*	**1.27**	**1.15**	**1.15**
PSI-10: Postop Physiologic and Metabolic Derangement*	1.21	1.19	1.17
PSI-11: Postop Respiratory Failure*	**1.35**	1.01	0.99
PSI-12: Periop PE or DVT	**1.28**	**1.28**	**1.28**
PSI-13: Postop Sepsis	**1.12**	1.04	1.02
PSI-14: Postop Wound Dehiscence	0.92	0.97	0.97
PSI-15: Puncture or Laceration	**0.79**	1.03	**1.07**

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism. All bolded/shaded comparisons significant at p<0.05.
1. GEE models; 2. Random effects models.
*Model did not converge due to small numbers for covariates; logistic model was used instead.

c) Hispanics

Measure	Unadjusted Odds of Event for	Risk-Adjusted Odds of Event for	Risk-Adjusted Within-Hospital Odds of Event for
PSI-3: Pressure Ulcer	1.13	1.08	0.93
PSI-6: Iatrogenic Pneumothorax	**0.78**	**0.88**	**0.86**
PSI-7: Catheter-Related BSI	1.00	0.93	0.91
PSI-8: Postop Hip Fracture	0.62	0.62	**0.54**
PSI-9: Postop Hemorrhage or Hematoma Rate*	1.05	0.97	0.97
PSI-10: Postop Physiologic and Metabolic Derangement*	1.06	0.97	1.01
PSI-11: Postop Respiratory Failure*	**1.17**	1.02	0.98
PSI-12: Periop PE or DVT	**0.86**	**0.90**	**0.90**
PSI-13: Postop Sepsis	1.11	1.14	1.08

PSI-14: Postop Wound Dehiscence	**0.71**	**0.75**	**0.74**
PSI-15: Puncture or Laceration	**0.91**	1.00	**1.05**

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism. All bolded/shaded comparisons significant at p<0.05.
1. GEE models; 2. Random effects models.
*Model did not converge due to small numbers for covariates; logistic model was used instead.

d) **Rural patient** (based on zip code of patient's residence)

Measure	Unadjusted Odds of Event for	Risk-Adjusted Odds of Event for	Risk-Adjusted Within-Hospital Odds of Event for
PSI-3: Pressure Ulcer	**0.79**	**0.81**	**0.81**
PSI-6: Iatrogenic Pneumothorax	1.03	1.03	1.03
PSI-7: Catheter-Related BSI	**0.80**	**0.78**	**0.84**
PSI-8: Postop Hip Fracture	1.07	1.08	1.14
PSI-9: Postop Hemorrhage or Hematoma Rate*	0.98	**0.97**	**0.97**
PSI-10: Postop Physiologic and Metabolic Derangement*	0.92	**0.89**	**0.89**
PSI-11: Postop Respiratory Failure*	0.98	**0.91**	**0.96**
PSI-12: Periop PE or DVT	**0.85**	**0.83**	**0.83**
PSI-13: Postop Sepsis	**0.93**	**0.92**	0.96
PSI-14: Postop Wound Dehiscence	1.08	1.06	1.05
PSI-15: Puncture or Laceration	**1.21**	**1.11**	**1.07**

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism. All bolded/shaded comparisons significant at p<0.05.
1. GEE models; 2. Random effects models.
*Model did not converge due to small numbers for covariates; logistic model was used instead.

e) **Disabled** (original reason for Medicare entitlement)

Measure	Unadjusted Odds of Event for	Risk-Adjusted Odds of Event for	Risk-Adjusted Within-Hospital Odds of Event for
PSI-3: Pressure Ulcer	**0.84**	**0.85**	**0.85**
PSI-6: Iatrogenic Pneumothorax	**0.73**	**0.89**	**0.87**
PSI-7: Catheter-Related BSI	**1.84**	**1.41**	**1.40**
PSI-8: Postop Hip Fracture	1.12	1.11	1.07
PSI-9: Postop Hemorrhage or Hematoma Rate*	**1.05**	**1.03**	**1.03**
PSI-10: Postop Physiologic and Metabolic Derangement*	**1.15**	0.96	0.93
PSI-11: Postop Respiratory Failure*	**1.31**	0.99	**0.97**
PSI-12: Periop PE or DVT	**0.82**	**0.78**	**0.78**
PSI-13: Postop Sepsis	**1.14**	1.03	1.02
PSI-14: Postop Wound Dehiscence	**1.37**	**1.23**	**1.21**
PSI-15: Puncture or Laceration	**0.85**	**1.06**	**1.04**

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism. All bolded/shaded comparisons significant at p<0.05.

1. GEE models; 2. Random effects models.
*Model did not converge due to small numbers for covariates; logistic model was used instead.

f) **Medically Complex** (beneficiaries with top 20% highest HCC scores)

Measure	Unadjusted Odds of Event for	Risk-Adjusted Odds of Event for	Risk-Adjusted Within-Hospital Odds of Event for
PSI-3: Pressure Ulcer	**1.41**	**1.29**	**1.27**
PSI-6: Iatrogenic Pneumothorax	**0.90**	**0.91**	**0.91**
PSI-7: Catheter-Related BSI	**2.01**	**1.73**	**1.69**
PSI-8: Postop Hip Fracture	**2.55**	**2.57**	**2.50**
PSI-9: Postop Hemorrhage or Hematoma Rate*	**1.40**	**1.17**	**1.17**
PSI-10: Postop Physiologic and Metabolic Derangement*	**1.68**	1.11	1.09
PSI-11: Postop Respiratory Failure*	**2.64**	**1.33**	**1.31**
PSI-12: Periop PE or DVT	**1.05**	**0.89**	**0.89**
PSI-13: Postop Sepsis	**1.72**	**1.31**	**1.30**
PSI-14: Postop Wound Dehiscence	**1.66**	**1.30**	**1.30**
PSI-15: Puncture or Laceration	**0.60**	**1.04**	**1.05**

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism. All bolded/shaded comparisons significant at p<0.05.
1. GEE models; 2. Random effects models.
*Model did not converge due to small numbers for covariates; logistic model was used instead.

g) Duals, adjusting for medical complexity (HCC risk quintiles)

This table shows the effect of dual on odds of a PSI event, after adjusting for unmeasured medical complexity (based on HCC risk quintiles with 1 year look-back). This table includes additional PSI-90 components in the modified PSI-90 measure, (PSI-9, 10 and 11).

Measure	Unadjusted Odds of Event for Duals, adjusting Medical Risk Quintiles[1]	Risk-Adjusted Odds of Event for Duals, adjusting Medical Risk Quintiles[1]	Risk-Adjusted, "Within-Hospital" Odds of Event for Duals, adjusting Medical Risk Quintiles[2]
PSI-3: Pressure Ulcer	1.08	**1.12**	1.03
PSI-6: Iatrogenic Pneumothorax	**0.86**	**0.95**	**0.94**
PSI-7: Catheter-Related BSI	**1.52**	**1.27**	**1.28**
PSI-8: Postop Hip Fracture	1.06	1.05	1.06
PSI-9: Postop Hemorrhage or Hematoma Rate*	1.00	1.00*	-
PSI-10: Postop Physiologic and Metabolic Derangement*	1.04	0.94	0.93
PSI-11: Postop Respiratory Failure*	**1.35**	**1.10**	**1.10**

PSI-12: Periop PE or DVT	0.97	0.91*	-
PSI-13: Postop Sepsis	**1.17**	**1.13**	**1.12**
PSI-14: Postop Wound Dehiscence	**1.35**	**1.34**	**1.32**
PSI-15: Puncture or Laceration	**0.74**	1.00	0.98

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism. All bolded/shaded comparisons significant at p<0.001.
1. GEE models; 2. Random effects models.
*Random effects model did not converge due to small numbers for covariates; logistic model was used instead.

h) Dual effect, with and without additional risk-adjustment of medical risk quintiles

	Unadjusted Odds of Event for Duals[1]		Risk-Adjusted Odds of Event for Duals[1]		Risk-Adjusted, "Within-Hospital" Odds of Event for Duals[2]	
Measure	**Unadjusted**	**After adjusting HCC medical risk quintiles**	**PSI-specific clinical adjustment only**	**after adjusting HCC medical risk quintiles**	**PSI-specific clinical adjustment only**	**after adjusting HCC medical risk quintiles**
PSI-3: Pressure Ulcer	**1.13**	1.08	**1.15**	**1.12**	1.06	1.03
PSI-6: Iatrogenic Pneumothorax	**0.84**	**0.86**	**0.93**	**0.95**	**0.92**	**0.94**
PSI-7: Catheter-Related BSI	**1.67**	**1.52**	**1.36**	**1.27**	**1.36**	**1.28**
PSI-8: Postop Hip Fracture	1.33	1.06	1.32	1.05	**1.33**	1.06
PSI-9: Postop Hemorrhage or Hematoma Rate	**1.08**	1.00	**1.03***	1.00*	1.03*	-
PSI-10: Postop Physiologic and Metabolic Derangement	**1.16**	1.04	0.96	0.94	0.95	0.93
PSI-11: Postop Respiratory Failure	**1.65**	**1.35**	**1.14**	**1.10**	**1.14**	**1.10**
PSI-12: Periop PE or DVT	0.98	0.97	**0.91***	**0.91***	**0.91***	-
PSI-13: Postop Sepsis	**1.30**	**1.17**	**1.18**	**1.13**	**1.17**	**1.12**
PSI-14: Postop Wound Dehiscence	**1.45**	**1.35**	**1.39**	**1.34**	**1.37**	**1.32**
PSI-15: Puncture or Laceration	**0.68**	**0.74**	1.01	1.00	0.99	0.98

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism. All bolded/shaded comparisons significant at p<0.001.
1. GEE models; 2. Random effects models.
*Random effects model did not converge due to small numbers for covariates; logistic model was used instead.

i) Hospital-specific dual effect in PSI-90

Random slope figure with the 3 added PSI indicators to the Modified PSI-90 measure (version 6), pending

1. Relationship between Hospital Share of Social Risk and PSI-90 components

These tables show the relationship between hospital share of patient social risk factors include DSH, Duals, SSI, Low-Income ZCTA, Blacks, Hispanics, Rural, Disabled Medically Complex and each of the PSI-90 components, including the new components PSI-9, 10 and 11 added to the modified PSI-90 (version 6) measure.

a) Safety-net Hospital: top 20% DSH Index

Measure	Unadjusted Odds of Event for Patients at Safety Net Hospitals (top 20% DSH)	Risk-Adjusted Odds of Event for Patients at Safety Net Hospitals (top 20% DSH)
PSI-3: Pressure Ulcer	1.45	1.36
PSI-6: Iatrogenic Pneumothorax	1.18	1.13
PSI-7: Catheter-Related BSI	1.49	1.22
PSI-8: Postop Hip Fracture	0.94	0.94
PSI-9: Postop Hemorrhage or Hematoma Rate*	1.29	1.13
PSI-10: Postop Physiologic and Metabolic Derangement*	1.65	1.36
PSI-11: Postop Respiratory Failure*	1.41	1.12
PSI-12: Periop PE or DVT	1.17	1.09
PSI-13: Postop Sepsis	1.26	1.17
PSI-14: Postop Wound Dehiscence	1.19	1.19
PSI-15: Puncture or Laceration	1.07	1.05

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism.
All bolded/shaded comparisons are significant at p<0.001.

b) Hospital top 20% Dual and Hospital top 20% Supplemental Social Security Income (SSI)

	Odds of Event for High-Dual Hospital		Odds of Event for High-SSI Hospital[1]	
Measure	Unadjusted	Clinically Risk-adjusted	Unadjusted	Clinically Risk-adjusted
PSI-3: Pressure Ulcer	1.48	1.58	1.35	1.33
PSI-6: Iatrogenic Pneumothorax	0.86	0.95	1.01	1.01
PSI-7: Catheter-Related BSI	1.02	0.98	1.27	1.11
PSI-8: Postop Hip Fracture	0.81	0.80	0.91	0.91
PSI-9: Postop Hemorrhage or Hematoma Rate*	0.96	0.96*	1.16	1.07*
PSI-10: Postop Physiologic and Metabolic Derangement*	1.12	1.01	1.26	1.06
PSI-11: Postop Respiratory Failure*	1.21	1.00	1.32	1.07
PSI-12: Periop PE or DVT	1.10	1.09*	1.14	1.12*
PSI-13: Postop Sepsis	1.09	1.07	1.24	1.21
PSI-14: Postop Wound Dehiscence	1.25	1.20	1.13	1.11
PSI-15: Puncture or Laceration	0.66	0.99	0.82	0.96

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism.
*Model did not converge due to small numbers for covariates; logistic model was used instead.
All bolded/shaded comparisons are significant at p<0.01.

c) Hospitals serving low-income area (defined as Hospital Service Area (HSA) and ZCTA-level Income in bottom 20%) Hospitals with top 20% share of low-income patients (based on ZCTA)

Low-Income Serving Hospitals	Odds of Event for Hospital Serving Low-Income Area		Odds of Event for Hospital High-Share of Low-Income Patients[1]	
Measure	**Unadjusted**	**Clinically Risk-adjusted**	**Unadjusted**	**Clinically Risk-adjusted**
PSI-3: Pressure Ulcer	0.91	1.02	0.98	1.03
PSI-6: Iatrogenic Pneumothorax	**0.75**	0.95	**0.91**	1.00
PSI-7: Catheter-Related BSI	**0.67**	0.82	1.01	1.05
PSI-8: Postop Hip Fracture	1.02	1.01	1.24	1.24
PSI-9: Postop Hemorrhage or Hematoma Rate*	**0.79**	**0.87**	0.98	**0.96***
PSI-10: Postop Physiologic and Metabolic Derangement*	0.81	0.82	1.17	1.05
PSI-11: Postop Respiratory Failure*	1.05	0.93	**1.29**	**1.10**
PSI-12: Periop PE or DVT	**0.84**	**0.87***	0.97	0.99*
PSI-13: Postop Sepsis	0.97	0.97	1.07	1.03
PSI-14: Postop Wound Dehiscence	**1.26**	1.24	1.11	1.10
PSI-15: Puncture or Laceration	**0.64**	0.95	**0.81**	0.97

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism.
*Model did not converge due to small numbers for covariates; logistic model was used instead.
All bolded/shaded comparisons are significant at p<0.01.

d) Minority-serving Hospitals: Hospitals with top 20% Hispanic and Hospitals with top 20% Black

Minority-Serving Hospitals	Odds of Event for High-Black Hospital		Odds of Event for High-Hispanic Hospitals	
Measure	**Unadjusted**	**Clinically Risk-adjusted**	**Unadjusted**	**Clinically Risk-adjusted**
PSI-3: Pressure Ulcer	1.12	1.07	**1.34**	**1.27**
PSI-6: Iatrogenic Pneumothorax	1.03	1.01	**1.18**	**1.11**
PSI-7: Catheter-Related BSI	**1.44**	**1.27**	**1.33**	**1.19**
PSI-8: Postop Hip Fracture	1.04	1.04	0.80	0.80
PSI-9: Postop Hemorrhage or Hematoma Rate*	**1.21**	**1.07***	**1.10**	**1.03***
PSI-10: Postop Physiologic and Metabolic Derangement*	**1.66**	**1.35**	1.12	0.98
PSI-11: Postop Respiratory Failure*	**1.37**	**1.10**	**1.24**	**1.10**
PSI-12: Periop PE or DVT	**1.31**	**1.27***	1.05	**1.03***
PSI-13: Postop Sepsis	**1.17**	1.06	**1.21**	**1.21**
PSI-14: Postop Wound Dehiscence	1.05	1.06	1.11	1.11
PSI-15: Puncture or Laceration	**0.91**	**0.91**	0.95	0.97

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism.

*Model did not converge due to small numbers for covariates; logistic model was used instead.
All bolded/shaded comparisons are significant at p<0.01.

e) Rural Hospitals – Hospitals with top 20% Rural Patients and Hospitals in Rural Locations (non-MSA)

Minority-Serving Hospitals	Odds of Event for High-Rural Hospital		Odds of Event for Rural Location Hospital	
Measure	**Unadjusted**	**Clinically Risk-adjusted**	**Unadjusted**	**Clinically Risk-adjusted**
PSI-3: Pressure Ulcer	1.10	1.18	**0.73**	**0.85**
PSI-6: Iatrogenic Pneumothorax	**0.82**	**0.85**	**0.73**	**0.95**
PSI-7: Catheter-Related BSI	**0.87**	0.94	**0.46**	**0.60**
PSI-8: Postop Hip Fracture	0.88	0.87	0.74	0.73
PSI-9: Postop Hemorrhage or Hematoma Rate*	**0.89**	**0.93***	**0.70**	**0.85**
PSI-10: Postop Physiologic and Metabolic Derangement*	**0.79**	0.86	**0.46**	**0.54**
PSI-11: Postop Respiratory Failure*	**0.91**	**0.90**	**0.73**	**0.75**
PSI-12: Periop PE or DVT	**1.16**	**1.18***	**0.65**	**0.66**
PSI-13: Postop Sepsis	0.97	1.02	**0.72**	**0.75**
PSI-14: Postop Wound Dehiscence	1.09	1.09	1.16	1.14
PSI-15: Puncture or Laceration	**0.68**	**0.87**	**0.77**	1.07

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism.
*Model did not converge due to small numbers for covariates; logistic model was used instead.
All bolded/shaded comparisons are significant at p<0.01.

f) **Disability and Medical Complexity: Hospitals with top 20% disabled patients and hospitals with top 20% medically complex patients** (medical complexity based on top quintile of Hierarchical Condition Category [HCC] scores)

Minority-Serving Hospitals	Odds of Event for High-Disabled Hospital		Odds of Event for High-Medical Complexity Hospital	
Measure	**Unadjusted**	**Clinically Risk-adjusted**	**Unadjusted**	**Clinically Risk-adjusted**
PSI-3: Pressure Ulcer	1.05	1.14	1.11	1.04
PSI-6: Iatrogenic Pneumothorax	**0.88**	1.01	**1.08**	1.03
PSI-7: Catheter-Related BSI	0.93	0.95	**1.23**	**1.20**
PSI-8: Postop Hip Fracture	1.20	1.20	1.21	1.20
PSI-9: Postop Hemorrhage or Hematoma Rate*	0.99	0.99*	**1.38**	**1.12***
PSI-10: Postop Physiologic and Metabolic Derangement*	**1.22**	1.12	**2.04**	**1.30**
PSI-11: Postop Respiratory Failure*	**1.25**	1.04	**1.84**	**1.17**
PSI-12: Periop PE or DVT	0.94	**0.95***	**1.38**	**1.32***
PSI-13: Postop Sepsis	1.04	0.98	**1.33**	**1.13**
PSI-14: Postop Wound Dehiscence	**1.27**	**1.21**	1.11	1.05

PSI-15: Puncture or Laceration	**0.81**	**1.10**	**0.85**	**0.90**

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism.
*Model did not converge due to small numbers for covariates; logistic model was used instead.
All bolded/shaded comparisons are significant at p<0.01.

2. Effect of Patient and Hospital Social Risk on PSI-90 Measure Outcomes

PSI-90: Patient Social Risk (Duals) and High-Dual (top 20% duals) Hospital Status in Single Model

Measure	Patient Effect Odds Ratio: Dual vs. Non-Dual, Controlling for Hospital Safety-Net Status (High-Dual)	Hospital Effect Odds Ratio: Safety-Net (High-Dual) vs. Non-Safety-Net, Controlling for Patients' Dual Status
PSI-3: Pressure Ulcer	**1.14**	**1.48**
PSI-6: Iatrogenic Pneumothorax	1.01	0.95
PSI-7: Catheter-Related BSI	**1.36**	0.97
PSI-8: Postop Hip Fracture	1.39	0.73
PSI-12: Periop PE or DVT	0.97	1.12
PSI-13: Postop Sepsis	**1.37**	1.02
PSI-14: Postop Wound Dehiscence	**1.56**	1.09
PSI-15: Puncture or Laceration	1.04	0.97

BSI=bloodstream infection; DVT=deep vein thrombosis; PE=pulmonary embolism.
1. GEE models; 2. Random effects models

All bolded/shaded comparisons are significant at p<0.001.

3. CDC Healthcare Associated Infection Measures – Rates by Hospital Social Risk

FY15 Healthcare Associated Infection Measures by Hospitals with High Share of Social Risk (top 20%)
(only CLABSI and CAUTI included in FY15 HACRP program. Measurement period for both measures is CY2012 and CY2013; measurement period for rest of the measures is CY2013.

CDC Measure	High-DSH Hospitals	Rest	Diff	p-value
CLABSI (2 year)	0.65	0.52	**0.13**	0.00
CAUTI (2 year)	1.02	0.93	**0.08**	0.03
SSI (Colon and Hysterectomy)	1.05	0.91	**0.14**	0.00
MRSA	1.05	0.88	**0.17**	0.00
C. Difficile	0.69	0.81	**-0.12**	0.00

CD Measure	High Dual	Other	Diff	p-value
CLABSI (2 year)	0.65	0.53	**0.12**	0.00
CAUTI (2 year)	0.86	0.97	**-0.11**	0.01
SSI (Colon and Hysterectomy)	1.05	0.93	0.12	0.09

MRSA	1.04	0.89	**0.15**	0.00
C. Difficile	0.66	0.82	**-0.16**	0.00

CDC Measure	High-SSI Hospitals	Rest	Diff	p-value
CLABSI (2 year)	0.66	0.52	**0.13**	0.00
CAUTI (2 year)	0.98	0.94	0.04	0.37
SSI (Colon and Hysterectomy)	1.03	0.93	0.10	0.07
MRSA	1.07	0.88	**0.19**	0.00
C. Difficile	0.69	0.81	**-0.12**	0.00

CDC Measure	High-Hispanic	Rest	Diff	p-value
CLABSI (2 year)	0.61	0.53	**0.08**	0.00
CAUTI (2 year)	0.99	0.94	0.04	0.27
SSI (Colon and Hysterectomy)	0.94	0.95	0.00	0.94
MRSA	0.95	0.90	0.05	0.27
C. Difficile	0.88	0.77	**0.11**	0.00

CDC Measure	High Black	Rest	Diff	p-value
CLABSI (2 year)	0.66	0.52	**0.14**	0.00
CAUTI (2 year)	1.00	0.94	0.07	0.09
SSI (Colon and Hysterectomy)	1.01	0.92	0.09	0.09
MRSA	1.15	0.85	**0.30**	0.00
C. Difficile	0.74	0.80	**-0.06**	0.01

CD Measure	High-Disabled	Rest	Diff	p-value
CLABSI (2 year)	0.61	0.54	**0.07**	0.02
CAUTI (2 year)	0.80	0.98	**-0.18**	0.00
SSI (Colon and Hysterectomy)	1.02	0.94	0.08	0.24
MRSA	1.14	0.88	**0.26**	0.00
C. Difficile	0.65	0.82	**-0.18**	0.00

CD Measure	Rural hospital	Rest	Diff	p-value
CLABSI (2 year)	0.52	0.55	-0.03	0.30
CAUTI (2 year)	0.71	1.03	**-0.32**	0.00
SSI (Colon and Hysterectomy)	0.79	0.96	-0.17	0.07
MRSA	0.89	0.92	-0.03	0.60
C. Difficile	0.63	0.85	**-0.22**	0.00

V. Impact of program on providers serving low-SES populations

Domain and Total HACR Score by Hospital Type for FY16

Note: using reported FY16 data, decile scoring, including hospitals missing DSH index, and excluding MD hospitals

Hospital Type	FY 2016 Domain 1: PSIs	FY 2016 Domain 2: CDC	FY 2016 Total HACRP Score	Difference in Total Score, vs other hospitals*
SNH (high DSH)	5.9	5.7	5.8	**0.4**
Low-income ZCTA Hospitals	5.5	5.1	5.3	-0.1
High-Black	5.8	5.7	5.8	**0.4**
High-Hispanic	5.6	5.6	5.6	**0.3**
High-Disabled	5.6	5.0	5.3	-0.2
Rural (non-MSA)	5.3	4.6	5.0	**-0.6**

MSA=metropolitan statistical area; SNH=safety-net hospital; SSI=supplemental security income. Bolded differences are statistically significant at p<0.01. *The comparisons here are for the hospital group of interest versus all hospitals not in that group; for example, safety-net versus non-safety-net, or rural versus non-rural.

Likelihood of Penalty and Average Penalty, by Hospital Type for FY16

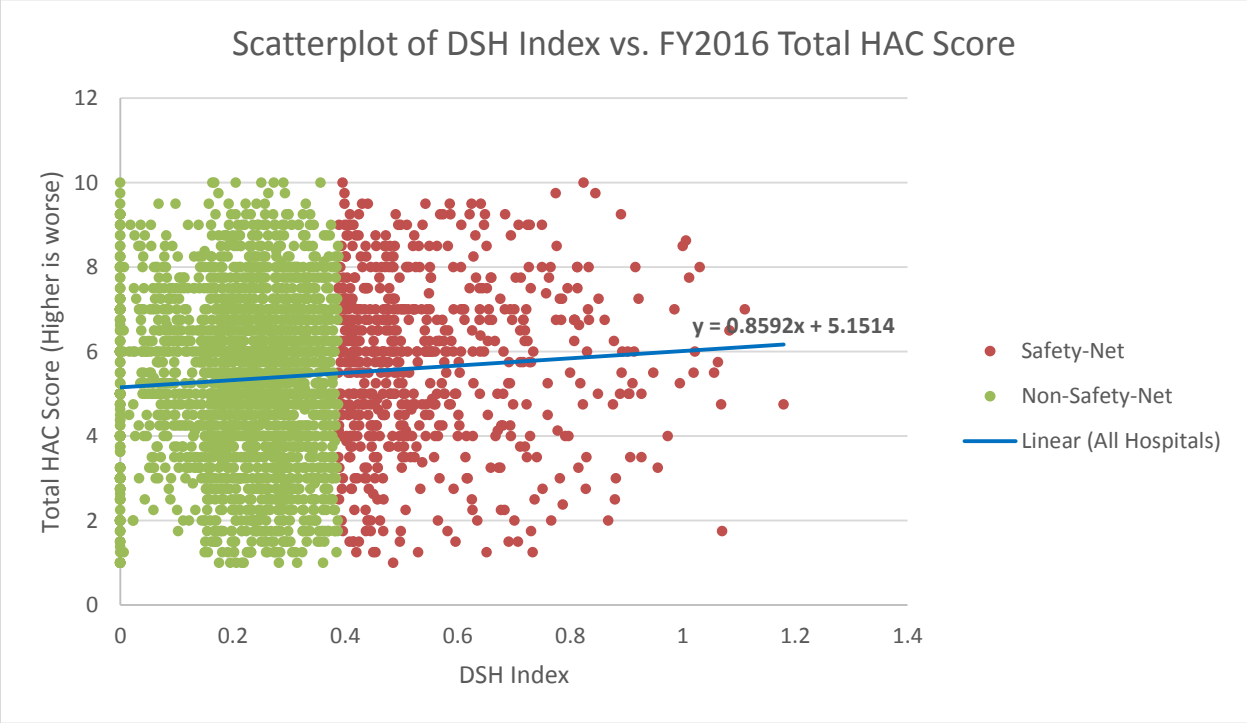
Note: using reported FY16 data, decile scoring, including hospitals missing DSH index, and excluding MD hospitals

Hospital Type	Proportion of Hospitals Penalized	Odds of Penalty (compared to hospitals not in the group of interest)	Average Penalty, Thousands of Dollars (among penalized hospitals)*
Overall Program	25%	n/a	$435
SNH (high DSH)	31%	**1.5**	$514
Low-income ZCTA Hospitals	23%	0.9	$326
High-Black	30%	**1.4**	$552
High-Hispanic	28%	1.3	$458
High-Disabled	24%	1.0	$319
Rural (non-MSA)	19%	**0.7**	$130
	All bolded comparisons are significant at p<0.001. *Penalty is 1% of total Medicare hospital payments.		

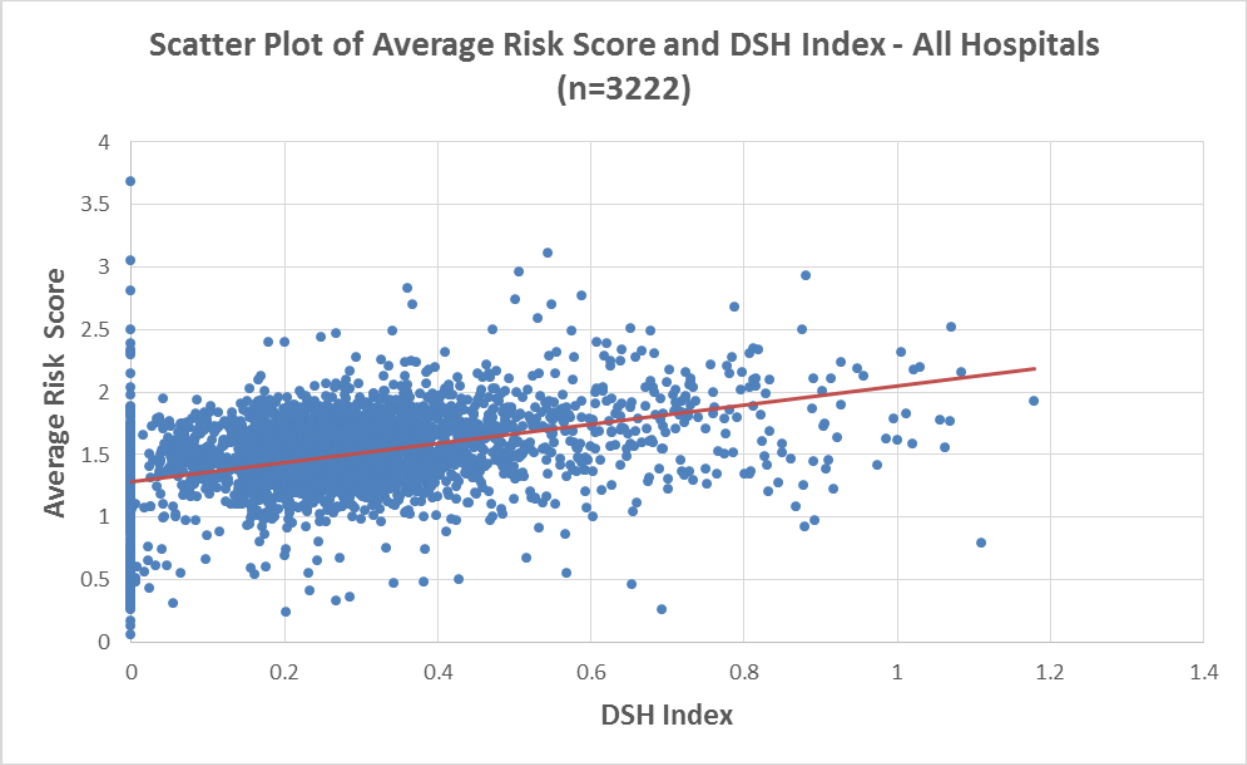
HACRP Decile Scores by Hospital DSH Index

		Average HACR score	% of each HACRP score decile, FY16 reported scores									
			1 better	2	3	4	5	6	7	8	9	10 worse
Deciles of DSH Index	1 low	5.0	11.2%	12.4%	13.4%	6.8%	11.8%	5.9%	12.4%	8.7%	8.7%	8.7%
	2	5.6	11.0%	13.2%	11.6%	10.0%	12.5%	5.0%	13.5%	6.9%	7.8%	8.5%
	3	5.1	6.6%	12.8%	10.3%	7.2%	10.9%	5.6%	13.4%	7.5%	12.2%	13.4%
	4	5.4	5.5%	11.0%	11.0	7.9	10.	10.	13.	8.5	9.8	12.

					%	%	1%	1%	7%	%	%	5%
	5	5.4	6.8%	7.1%	7.1%	9.2%	14.8%	9.5%	14.2%	7.4%	12.0%	12.0%
	6	5.2	7.4%	12.8%	9.6%	7.1%	12.5%	9.9%	13.5%	5.8%	8.7%	12.8%
	7	5.4	6.0%	9.7%	9.7%	7.5%	13.8%	7.9%	18.2%	9.1%	8.2%	9.7%
	8	5.3	5.8%	7.7%	6.7%	8.0%	10.2%	8.6%	15.3%	10.5%	14.7%	12.5%
	9	5.8	6.7%	12.8%	7.6%	11.9%	12.2%	8.8%	13.7%	8.2%	12.8%	5.2%
	10 high	5.8	8.2%	7.2%	12.4%	2.4%	12.4%	2.4%	14.4%	9.6%	11.3%	19.6%



Hospital DSH Index and Hospital Average HCC Risk Score (based on 2013 RAPS File)



II. Policy Options – additional tables

Improvement – These tables show the proportion of hospitals who improved among those penalized in FY 2016 and the estimated average penalty amount avoided as a result of allowing buy-down of the penalty based on improvement or improvement scaled on DSH.

	Among Penalized Hospitals	Option: Improvement Impacts Among Improved Hospitals	
Hospital Type	**% Improved**	**Average Percentile Ranking Improvement**	**Average Avoided Penalty Amount in Thousands of Dollars**
Safety-Net (top 20% DSH)	9.39%	6.6	$179
Non Safety-Net (all other)	6.99%	6.9	$148
Difference	**2.40%**	**-0.3**	$30

	Among Penalized Hospitals	Option: Improvement Scaled by DSH Impacts Among Improved Hospitals

Hospital Type	% Improved	Average Percentile Ranking Improvement	Average Avoided Penalty Amount in Thousands of Dollars, Scaled by DSH	Average Avoided Penalty Amount in Thousands of Dollars, Scaled by DSH+1*
Safety-Net (top 20% DSH)	9.39%	6.6	$99	$277
Non Safety-Net (all other)	6.99%	6.9	$38	$186
Difference	**2.40%**	**-0.3**	**$61**	$91

*Note: DSH index is truncated to 1 for hospitals with a DSH Index>1

Program impacts: option for linear penalty with 50% of hospitals penalized and maximum penalty of 2% of base DRG payments

Hospital Type	% Penalized Under Current Policy	% Penalized Under Linear Scale, 50% of Hospitals, 2% Cap	Average Penalty Under Current Policy	Average Penalty Under Linear Scale, 50% of Hospitals, 2% Cap
Safety-Net (top 20% DSH)	29.9%	60.2%	$606	$374
Non Safety-Net (all other)	20.1%	47.4%	$446	$310
Difference	**9.7%**	12.7%	$446	$64
Bolded comparisons are significant at p<0.001				

Proportion of Hospitals Penalized by DSH Index Categories, Comparison of Scoring by Deciles and Winsorized Z-Scores

	ASPE Results: Winsorized Z-Score* (excludes MD hospitals, and hospitals missing DSH Index**)		CMS/MPR Results (FY2016) Deciles vs. Winsorized Z-Scores		
DSH Index Category	**Count**	**Percent Penalized**	**Count**	**Deciles**	**Z-scores**
All	3176	25.3%	3304	25%	25%
DSH 0-24%	1498	22.6%	1559	24%	25%
DSH 25-49%	1365	25.6%	1390	24%	23%
DSH 50-64%	163	33.7%	174	28%	34%
DSH 65+%	150	39.3%	161	29%	33%

*Winsorized Z-scores are applied to FY16 reported measure rates

**ASPE analysis used 2012 Medicare Cost Reports to identify DSH Index; Maryland hospitals are not subject to HACRP penalty

Proposed HACR scoring using Winsorized Z-scores - Proportion of Hospitals Penalized by DSH Quintiles

Proportion of Hospitals Penalized if HACRP uses Z-Scores		
DSH Quintile Category	**Threshold**	**Hospitals Penalized, %**
All hospitals		25.3%

Quintile 1: 0-15%		22.3%
Quintile 2: 15.3% - 22.6%	0.1533	20.3%
Quintile 3: 22.6% - 28.9%	0.2260	24.5%
Quintile 4: 28.9% - 38.8%	0.2891	25.2%
Quintile 5 (top 20% DSH): 38.8% +	0.3881	33.9%

*Winsorized Z-scores are applied to FY16 reported measure rates

CMS Proposed Changes Plus Stratification Option: Proportion of Hospitals Penalized by DSH Quintiles, if HACR program uses Winsorized Z-scores and Modified PSI-90 (with harms weights)

	Number of Hospitals	Penalty Cutoff Point (if >= then penalize)	% Hospital penalized
Non-Safety-Net	2572	0.241	25.00%
Safety-Net	650	0.501	24.92%

DSH Quintile	Number of Hospitals	Penalty Cutoff Point (if >= then penalize)	% Hospital penalized
1	630	0.127	24.92%
2	643	0.219	25.04%
3	642	0.313	24.92%
4	657	0.296	24.96%
5	650	0.501	24.92%

Appendix Chapter 7: The Hospital Value-Based Purchasing Program

Contents:

A. Detailed Methods

1. Overview – Variables and Data Sources
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A. Detailed Methods

1. Overview – Variables, Data Sources

- **Patient social risk & related risk factors**

Medicare beneficiaries' social risk factors were identified from various sources. Using Medicare enrollment data, patients' social risk factors were identified, including Blacks and Hispanics recoded from Medicare data by RTI, dually eligible for Medicaid and Medicare (including full and partially eligible for dual benefits), disability based on the original reason for Medicare entitlement. Census data was also used to identify patients residing in low-income neighborhoods with the lowest median household income at the Zip code tabulation area (ZCTA) and patients from rural areas defined as a non-Metropolitan Statistical Area (MSA). In addition, patients' with high medical risk or medical complexity were identified based on the highest quintile of HCC scores from a prior year of Medicare claims data in the RAPS file. HCC scores are used for Medicare Advantage risk-adjustment. The table below identifies the patient social risk factors and the relevant data sources used in these regression analyses.

Beneficiary Factor	Data Sources	Definition
Dual Eligible	Enrollment Database	Beneficiary was eligible for both Medicare and Medicaid in the three months before admission date, month of admission date, or three months after admission date. If the DUAL_MDCR variable is part of the list below, the beneficiary is deemed dual eligible: • 01 = Eligible is entitled to Medicare- QMB only • 02 = Eligible is entitled to Medicare- QMB AND Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) • 03 = Eligible is entitled to Medicare- SLMB only • 04 = Eligible is entitled to Medicare- SLMB AND Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) • 05 = Eligible is entitled to Medicare- QDWI • 06 = Eligible is entitled to Medicare- Qualifying individuals • 07 = Missing in latest data dictionary and shows up rarely (<.001%); consulting with analogous MAX variable suggested that this is the same as 06 • 08 = Eligible is entitled to Medicare- Other Full Dual Eligibles (Non QMB, SLMB,QWDI or QI)with Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) • 09 = Eligible is entitled to Medicare – Other Dual Eligibles

Beneficiary Factor	Data Sources	Definition
		but without Medicaid coverage, includes Pharmacy Plus and 1115 drug-only demonstration.
Low-Income	Enrollment Database 5-year ACS estimates UDS Mapper Zip to ZCTA crosswalk (2014)	All ZIP Code Tabulation Areas (ZCTAs) were ranked based on their American Community Survey (ACS) 5-year estimates of median household income. A cut-off for the lowest quintile of ZCTA-level income was determined using these rankings. ZCTAs that had a median household income below the cut-off were "low-income." The beneficiary's most recent zip code of residency before the admission date was used to determine which zip code and corresponding ZCTA to assign to a stay. Any stay that was assigned a "low-income" ZCTA was then flagged as a "low-income" stay.
Black	Master Beneficiary Summary File	Beneficiary has RTI race code= 2 "Black (or African-American)"
Hispanic	Master Beneficiary Summary File	Beneficiary has RTI race code= 5 "Hispanic"
Rural	Enrollment Database	The beneficiary's most recent county and state of residency before the admission date was used to determine if they resided in a Metropolitan Statistical Area (MSA). Any stay that was non-MSA was considered "rural."
Disabled	Enrollment Database	If the beneficiary's original reason for Medicare entitlement is "disability" then the stay was flagged as "disabled." Stays with beneficiaries who were entitled to Medicare because of age and who are also disabled were not included in this category.
Medical Complexity/ Risk Quintile	RAPS file	Each beneficiary's history of HCCs used for Medicare Advantage risk-adjustment for the calendar year prior to year of inpatient stay admission was used to calculate a clinical risk score. Stays were then split into risk quintiles based on these scores, and the highest quintile was flagged for "Medical Complexity."

- **Hospital social risk & related risk factors**

Using Medicare enrollment data to identify patient characteristics, hospitals were classified based on the top quintile share of the social risk factor of interest.

Provider Risk Factor	Data Source	Definition
High Dual	Stay-level beneficiary dual flag from HRRP stays	Provider had top 20% highest proportion of "Dual" stays in observation period
High Low-Income	Stay-level beneficiary low-income flag from HRRP stays	Provider had top 20% highest proportion of "Low-Income" stays in observation period

High Black	Stay-level beneficiary Black flag from HRRP stays	Provider had top 20% highest proportion of "Black" stays in observation period
High Hispanic	Stay-level beneficiary Hispanic flag from HRRP stays	Provider had top 20% highest proportion of "Hispanic" stays in observation period
Rural	CASPER	Provider is located in non-MSA
High Disabled	Stay-level beneficiary disabled flag from HRRP stays	Provider had top 20% highest proportion of "Disabled" stays in observation period
High Medical Complexity	Stay-level beneficiary Medical Complexity flag from PSI-90 eligible stays, RAPS file	Provider had top 20% highest proportion of "Medical Complexity"
DSH Index/DSH top 20%	Hospital Cost Report (2012)	Disproportionate Share Index; Flag for providers with top 20% highest DSH index

- **Hospital VBP Performance Data**

Through Hospital Compare, CMS provides hospital's performance on HVBP with measure rates, relevant scores at the measure, domain and total performance scores, as well as a separate file with the HVBP payment adjustment factors. Performance and payment adjustment was examined for hospitals who disproportionately serving socially at-risk patients to determine if they were more likely to have lower scores and more likely to have financial penalties.

- **Patient-level analyses: Medicare claims-based measures**

For HVBP, there are 3 sets of claims-based measures that can be used for patient-level analyses to examine the relationships between patient social risk and measure outcomes. These measures are the Medicare Spending per Beneficiary (MSPB) measure in the Efficiency domain, 3 condition-specific mortality measures in the Outcomes domain, and the PSI-90 patient safety composite measure also in the Outcomes domain; this measure is explored in the HACRP chapter. Specific methods for calculating each of the claims-based measures and specific analyses are described in more detail below.

Program Year	Measures Calculated using Medicare Claims
2015, 2016	Medicare Spending per Beneficiary (MSPB)
2015	30-day mortality for Heart Failure (HF)
2015	30-day mortality for Acute Myocardial Infarction (AMI)
2015	30-day mortality for Pneumonia (PN)

- **Estimating SES effect using GEE and RE models**

In general for all the patient-level analyses, generalized estimating equation (GEE) and random effects regression models were used to estimate the total and within-hospital effect of patient social risk on measure outcomes. Models included both patient social risk and hospital social risk, separately and together, to assess if observed hospital effects may be reduced after adjusting for patient's social risk.

2. Efficiency Domain: Medicare Spending per Beneficiary (MSPB) measure

2.1 Creating Medicare spending per beneficiary episode

A Medicare Spending Per Beneficiary (MSPB) episode consists of all Medicare Part A and Part B claims that occur between 3 days prior to an index hospitalization, through 30 days after discharge. Episodes that have an index discharge during the observation period and at least 30 days before the end of the observation period are included in the measure calculations. Table 1 shows the observation period for the program years that were used in HVBP policy simulation analysis:

Table 3: Hospital Baseline/Performance Periods for MSPB Measure

Program Year	Period Type	Dates
FY 2015	Baseline	May-December 2011
	Performance	May- December 2013
Fy 2016	Baseline	January-December 2012
	Performance	January-December 2014

2.2 MSPB risk adjustment variables

The MSPB episodes included in the observation period are split by Major Diagnostic Category (MDC), and using a separate linear regression model for each MDC, the MSPB episodes are risk-adjusted by the following variables based on a 90-day look-back of Medicare claims data:

- Age (split into categories)
- HCC indicators (90 days prior to start of episode)
- Long-term care indicator
- MS-DRG of index hospitalization
- Originally disabled indicator
- ESRD indicator
- Interaction terms for HCCs and enrollment status variables

These risk adjustment variables are patients' demographic and clinical characteristics that may affect the spending, independent of the hospital's performance. This process is referred to as the "first-level" regression in documentation. When socioeconomic status factors are said to be added to the measure's risk-adjustment, it is at this first step.

2.3 MSPB measure calculation

The results of the MDC level regressions described in section 2 are used to create the MSPB Measure using the following steps:

- **Truncate predicted values and exclude outliers**
  Truncate predicted values at the 0.5^{th} percentile to have the value of the 0.5^{th} percentile and then renormalize by multiplying truncated values by the average standardized spending level within each MDC and the average truncated predicted spending level within each MDC. Calculate residuals. Any stay with a residual above the 99^{th} percentile or below the 1^{st} percentile are excluded and the remaining stays are renormalized.

- **Calculate MSPB Amount for Each Hospital**
  MSPB Amount= (average standardized spending of hospital/ average predicted spending of hospitals) * average spending across all hospitals
- **Calculate the MSPB measure**
  MSPB measure = MSPB Amount/ Weighted National Median MSPB Amount
  The national median is weighted by number of episodes in each hospital.
- **Use MSPB Measure Amount for hospitals with more than 25 episodes**
  Take out any hospitals that have less than 25 episodes.

2.4 MSPB analyses at patient-level

For the patient-level MSPB analyses, examining the episode ratio at the patient-level was the primary approach. Subsequently, spending was examined by setting to identify potential drivers of higher spending observed in duals. In policy simulations (described later), including duals into the measure risk-adjustment was examined. In addition, risk-adjusting for frailty (using a frailty index - a count of conditions associated with being frail) was explored, to determine if this would reduce the observed higher spending by duals.

- **2.4.1 MSPB episode ratio analysis**

  Overview: This patient-level analysis explores the relationship between patient social risk factors and the ratio of standardized episode spending amount to predicted episode spending amount. This MSPB episode ratio is at the patient-level, derived after the first few steps of the measure calculations, without going on to calculate the MSPB amount for the hospital.

  Outcome of interest: episode ratio

  Method for calculating outcome of interest:

  - Episode Ratio= (Standardized episode payment amount)/(Predicted episode payment amount)
    - Standardized episode payment amount is the episode spending after claim payments in each episode has been standardized for geographic variation
    - Predicted episode payment amount is the expected episode spending determined through risk adjustment, after the process of truncation and outlier exclusion
  - "First-level" regression: standardized episode payment= MSPB risk adjustment variables *(for options that include SES variables in the risk-adjustment, this would be where the SES factor is added)*
  - "Second-level" regression: episode ratio= social risk factor
    - Betas displayed in workbook are the betas from these regressions that include the social risk factor of interest. Each risk factor is examined separately.

  - **Interpretation using dual as example:**
    - Episode ratio >1 indicates under predication (standardized>predicted)

- Episode ratio <1 indicates over prediction (standardized < predicted)
- Positive coefficient on dual- On average, duals have larger episode ratios compared to non-duals, indicating duals are getting under-predicted compared to non-duals
- Negative coefficient on dual- On average, duals have smaller episode ratios compared to non-duals, indicating duals are getting over-predicted compared to non-duals

- **2.4.2 MSPB settings**

Overview: This patient-level analysis explored the relationship between SES factors and spending in different care settings that contribute to an episode spending amount. Based on the high spending observed among duals, this analysis seeks to understand which settings drive the higher spending and understand if utilization or higher costs in specific settings contributes to higher spending in duals. Utilization rates in each setting are examined by the patient social risk factor. Then standardized and predicted spending in dollars are reported in each setting by patient social risk factor. Finally the difference in standardized and predicted spending are calculated by setting and social risk factor, to compare if differences are larger (or smaller) for socially at-risk patients and elicit if the risk-adjustment model is adequately predicting costs for specific patient subgroups. Interpretations of the differences are provided below.

Outcome of interest: difference in standardized and predicted spending

Method for calculating outcome of interest:

- Setting-specific difference= setting-specific standardized payment amount – setting-specific predicted payment amount
  - Standardized payment amount is the spending after claim payments has been standardized for geographic variation, in the particular setting of interest
  - Predicted episode payment amount is the expected episode spending determined through risk adjustment (for setting-specific analysis, truncation and outlier exclusion steps were not included)
- "First-level" regression: setting-specific standardized payment amount = MSPB risk adjustment variables
- "Second-level" regression: setting-specific "difference"= social risk factor + MDC
  - Includes MDC as independent variable to account for spending differences across MDCs
  - Betas displayed are the from these regressions

Interpretation using dual as example:

- Positive "difference" indicates under prediction (standardized > predicted)
- Negative "difference" indicates over prediction (standardized < predicted)

- Positive coefficient on dual- duals have a bigger "difference" than non-duals, indicating duals are getting under-predicted compared to non-duals
- Negative coefficient on dual- duals have a smaller "difference" than non-duals, indicating duals are getting over-predicted compared to non-duals

- **2.4.3 Risk-adjusting for Frailty in MSPB measure**

Overview: This patient-level analysis also explored the relationship between a frailty index and MSPB spending to determine if unmeasured medical risk due to patient frailty may partly explain the observed dual effect in socially at-risk patients. For each MSPB episode frailty is included in the MSPB measure's risk-adjustment either as 12 frailty indicators or as a count of frailty indicators summed into a frailty index along with all other clinical covariates in the "first-level" regression. In the "second-level" regression, the beta or spending for dual patients is estimated and compared to the beta for duals without including the frailty indicators or index in the measure's risk-adjustment model. If the dual effect is diminished after adjusting for frailty, this would suggest frailty (and other unmeasured medical comorbidity or risk) may be one of the reasons explaining the observed effect of social risk.

First-level regression (3 models):

1) Standardized payment amount = Current MSPB measure risk-adjustment
2) Standardized payment amount = Current risk-adjustment + 12 Frailty Indicators
3) Standardized payment amount = Current risk-adjustment + Frailty Index (ref group, index=0)

The data source for the frailty-associated conditions are ICD-9 codes or HCCs from Medicare claims in the Medicare Enrollment Database. The table below shows the relevant ICD-9 and HCC codes to identify the 12 frailty indicators.

Frailty Indicators Identified from Medicare Claims with the following ICD-9 codes or HCCs
If the following codes were present in Part A and B claims during look-back period (365 days before the start of MSPB episode, i.e. before the pre-index admission period), then they were flagged for indicator:
Abnormality of gait- ICD-9 DGN 781.2
Protein-Calorie Malnutrition- HCC 21
Adult failure to thrive- ICD-9 DGN 783.7
Cachexia- ICD-9 DGN 799.4
Debility- ICD-9 DGN 799.3
Difficulty in walking- ICD-9 DGN 719.7
Fall- ICD-9 DGN V15.88
Muscular wasting and disuse atrophy- ICD-9 DGN 728.2
Muscle weakness- ICD-9 DGN 728.87
Decubitus ulcer of skin- HCC 148
Senility without mention of psychosis- ICD-9 DGN 797
Durable medical equipment (cane, walker, bath equipment, and commode) - HCPCS Codes E0100, E0105, E0130, E0135, E0140, E0141, E0143, E0144, E0147-E0149, E0160-E0171
Frailty Index = Number of Frailty indicators present for each MSPB episode (0-12)

3. Outcomes Domain: Mortality Measures

3.1 Calculating Condition-Specific Mortality measures from Medicare claims data

The HVBP program includes the 30-day all-cause risk-standardized mortality measures in the outcome domain for three conditions: Acute Myocardial Infraction (AMI), Pneumonia (PN), and Heart Failure (HF).

The index admissions for each condition category were determined based on the methodology specified in the Measures Updates and Specifications Report, which was written for the Hospital Inpatient Quality Reporting (IQR) program. The mortality measures for the HVBP program differ from the IQR program in that it is made up of index stays for Medicare beneficiaries only, has a shorter observation period, and ultimately uses survivability instead of mortality to calculate hospital performance.

Table 4: Hospital Baseline/Performance Periods for Mortality Measures in HVBP

Program Year	Period Type	Dates
FY 2015	Baseline	Oct 2010- Jun 2011
	Performance	Oct 2012-Jun 2013
FY 2016*	Baseline	Oct 2010- Jun 2011
	Performance	Oct 2012-Jun 2014

***** *All FY 2016 mortality scores used in analysis were reported scores from Hospital Compare.*

3.2 Risk-adjustment

The following characteristics are included as covariates in a hierarchical logistic regression:

- Patient age
- Patient gender
- Comorbidities in 12 months prior to and during the index admission (that are not complications of care)

3.3 Mortality stay-level analysis

- Step 1: compute and attach SES variables described in table 1 and table 2
- Step 2: Run GEE and RE regressions with and without CMS risk-adjustment
- Step 3: Calculate odds ratios and risk-adjusted rates from regression output

3.4 Mortality measure for HVBP

The predicted rates calculated in sections 3.2 were used to calculate a hospital's final score for each mortality measure using the following steps:

- **Calculate predicted and expected rates**

- Predicted mortality for each hospital is estimated using average patient mix across all hospitals, and the hospital-specific intercept: it measures how the hospital performs given average patient mix.
- Expected mortality for each hospital is estimated using hospital specific patient mix, and the average of the hospital-specific intercept: it measures how the hospital performs with its specific patient mix if the hospital has the average performance among all hospitals.

- **Calculate risk-adjusted mortality rate**
  - Risk adjusted mortality rate = (predicted mortality/expected mortality) * national observed mortality rate
- **Convert to a survival rate**
  - Risk-adjusted survival rate= (1- risk-adjusted mortality rate)
- **Calculate achievement score, improvement score, and final score**

4. Policy Simulations

Program Years

Policy options were conducted on hospitals that were included in the FY 2016 HVBP program, using MSPB calculated from Medicare claims (see section 2). All other measures were reported scores from Hospital Compare.

Scoring Methodology

- Total Performance Score (TPS): for the calculation of hospital Total Performance Score, the detailed methods can be found here.
  - Measure score (MSPB)
    - For each hospital, an achievement score is calculated based on this hospital's performance comparing with all hospitals.
    - For each hospital, an improvement score is calculated based on this hospital's performance comparing with its own rates from the baseline period.
    - The higher of the two scores is used as the final score for that measure.
  - Domain score is the average of final measure scores within that domain.
  - Total Performance score is the weighted average of non-missing domain scores.

- Payment Adjustment Factor (PAF):
  - A linear exchange function is used with the Total Performance Score (TPS) to distribute the 1.5% DRG payments across all eligible HVBP hospitals. For each hospital, a Payment

Adjustment Factor is calculated. A PAF >1 indicates bonus payment, and a PAF<1 means penalty. Details on calculating linear exchange function slope and PAF can be found here.

Summary of Policy Options

Option	Specifics of Option
1. Status Quo	No changes to HVBP program
2. Adjustment	Adjust MSPB for dual status
3. Program Changes	Remove patient safety measures, as duplicates with HACR program
4. Adjustment and Program Changes	Risk-adjust MSPB, and remove the patient safety measures from program

Option 1: Current HVBP Program

No change to the current HVBP program.

Option 2: Adjustment

- Add the SES factor dual as a covariate in the risk-adjustment model for MSPB (see section 2.2).
- No other changes were made to how the MSPB score was calculated or to the other three domains.

Option 3: Program Changes

- This option modeled the effect of removing all the patient safety measures from the HVBP outcomes domain. For FY 2015, the PSI composite and CLABSI measures were removed. For FY 2016, the PSI composite, CLABSI, CAUTI, and SSI measures were removed.
- In the original FY2015 HVBP program methodology, the outcome domain score requires at least 2 measures that meet minimum case threshold. Due to the decrease in the number of measures (seven to three) under the outcome domain in FY2016, this requirement is changed to 1 measure meeting minimum case threshold.
- No change to other three domains.

Option 4: Adjustment and Program Changes

- Add the SES factor dual as a covariate in the risk-adjustment model for MSPB (see section 2.2).

- Remove patient safety measures from the outcomes domain. For FY 2015, the PSI composite and CLABSI measures were removed. For FY 2016, the PSI composite, CLBASI, CAUTI, and SSI measures were removed.
- In the original methodology, the outcome domain score requires at least 2 measures that meet minimum case threshold. Due to the decrease in the number of measures (seven to three) under the outcome domain, this requirement is changed to 1 measure meeting minimum case threshold.

- No changes to other two domains.

B. Supplemental Tables

1. **HVBP Domain Weights and Measures by Year**
2. **Safety-net definition, quintile thresholds for each SES factor (HACR, HVBP) including DSH**
3. **Patient and Provider Characteristics, by mortality, overlap in provider types**
4. **MSPB**
5. **Frailty**
6. **Mortality**
7. **Program Impacts**
8. **Policy Options**

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1. HVBP Domain Weights and Measures by Year

Pending

2. Safety-net definition, quintile thresholds for each SES factor (HACR, HVBP) including DSH

Table 2.1 DSH quintile thresholds

Pending

Table 2.2 . Hospital serving socially-at-risk patient populations, social risk factor overlap

Provider SES Factor	Top 20% DSH	Top 20% SSI	Top 20% Medicaid	Top 20% Dual	Top 20% Disabled	Top 20% Black	Top 20% Hispanic
Top 20% DSH	100.0%	68.2%	50.7%	56.8%	35.4%	40.9%	49.3%
Top 20% SSI	71.8%	100.0%	38.3%	70.6%	44.9%	45.7%	50.4%
Top 20% Medicaid	51.4%	36.8%	100.0%	36.8%	30.2%	30.9%	28.3%
Top 20% Dual	64.3%	75.8%	41.1%	100.0%	52.1%	44.0%	44.6%
Top 20% Disabled	39.4%	47.4%	33.1%	51.2%	100.0%	41.3%	13.9%
Top 20% Black	43.0%	45.5%	32.0%	40.8%	39.0%	100.0%	21.4%

Top 20% Hispanic	51.8%	50.2%	29.3%	41.4%	13.1%	21.4%	100.0%

Legend:	**0-19%**	**20-38%**	**39-49%**	**50-59%**	**60-69%**	**70+%**

Safety-net hospitals defined as top 20% DSH Index were also more likely to serve higher proportions of socially at-risk patient populations, >70% of hospitals were also in the top quintile (top 20%) of SSI share, 64% were high-Dual hospitals, more than 50% were high-Medicaid and high-Hispanic and 43% were high-Black hospitals. Similar patterns held for high-SSI and high-Dual hospitals, although they had lower proportion of high-Medicaid hospitals (a bit more than a third compared with nearly 50% for high-DSH hospitals).

Minority –serving hospitals tended to also include significant portions of high-Hispanic or High-Black hospitals, but did not have as many safety-net hospitals. However high-Hispanic hospitals included nearly half of all high-SSI hospitals. High-Disabled hospitals also included a significant portion of high-SSI hospitals and high-Dual hospitals.

3. Patient and Provider Characteristics based on mortality measures

3.1 Patient Characteristics

3.1.1 Mortality – AMI

Patient Characteristics	All	Dual	Disabled	Black	Hispanic	Low-Income ZCTA	Rural	Medically Complex
N Stays	184,206	38,208	27,045	15,699	11,124	28,862	42,466	37,222
% All stays	100.0%	20.7%	14.7%	8.5%	6.0%	15.7%	23.1%	20.2%
% Male	52.5%	37.9%	59.3%	42.6%	53.2%	50.0%	54.3%	50.5%
% Dual	20.7%	100.0%	34.4%	43.0%	52.4%	35.4%	22.0%	31.3%
% Disabled	14.7%	24.3%	100.0%	25.1%	18.5%	21.3%	17.6%	22.8%
% Black	8.5%	17.7%	14.6%	100.0%	0.0%	23.0%	5.6%	12.4%
% Hispanic	6.0%	15.3%	7.6%	0.0%	100.0%	11.0%	2.1%	8.1%
% Low Income ZCTA	15.7%	26.7%	22.8%	42.2%	28.6%	100.0%	26.1%	17.6%

% Rural	23.1%	24.5%	27.7%	15.0%	8.0%	38.3%	100.0%	19.7%
% High Complexity	20.2%	30.5%	31.3%	29.5%	27.0%	22.8%	17.3%	100.0%
Mean Age	78.53	78.33	73.20	77.05	77.22	77.57	77.79	78.61
Median Age	78	78	72	76	77	77	77	78

Patient Characteristics (top 10 Hierarchical Condition Categories)	**All**	**Dual**	**Disabled**	**Black**	**Hispanic**	**Low-Income ZCTA**	**Rural**	**Medically Complex**
% with HCCs (in order of prevalence among all stays)	28%	38%	38%	39%	33%	32%	27%	76%
HCC80: Congestive Heart Failure	27%	33%	32%	31%	32%	27%	22%	51%
HCC105: Vascular Disease	24%	30%	29%	32%	31%	26%	21%	58%
HCC131: Renal Failure	23%	32%	35%	23%	22%	27%	24%	53%
HCC108: Chronic Obstructive Pulmonary Disease	23%	24%	24%	20%	19%	21%	21%	48%
HCC92: Specified Heart Arrhythmias	20%	22%	24%	23%	20%	22%	23%	19%
HCC19: Diabetes without Complication	14%	15%	19%	14%	16%	14%	12%	24%
HCC83: Angina Pectoris/Old Myocardial Infarction	13%	17%	20%	16%	19%	13%	11%	33%
HCC71: Polyneuropathy	12%	18%	19%	20%	25%	14%	8%	34%
HCC15: Diabetes with Renal or Peripheral Circulatory Manifestation	9%	12%	13%	10%	10%	10%	8%	33%
HCC79: Cardio-Respiratory Failure and Shock	28%	38%	38%	39%	33%	32%	27%	76%

3.1.2 Mortality – HF

Patient Characteristics	**All**	**Dual**	**Disabled**	**Black**	**Hispanic**	**Low-Income ZCTA**	**Rural**	**Medically Complex**

N Stays	335,860	84,792	54,675	40,906	19,547	55,739	63,376	69,257
% All stays	100.0%	25.2%	16.3%	12.2%	5.8%	16.6%	18.9%	20.6%
% Male	45.6%	32.2%	53.4%	40.0%	45.3%	43.1%	46.8%	48.5%
% Dual	25.2%	100.0%	38.9%	46.3%	59.9%	40.7%	28.0%	33.9%
% Disabled	16.3%	25.1%	100.0%	27.7%	19.8%	23.2%	20.1%	24.3%
% Black	12.2%	22.3%	20.7%	100.0%	0.0%	31.9%	8.7%	14.9%
% Hispanic	5.8%	13.8%	7.1%	0.0%	100.0%	10.2%	2.2%	7.6%
% Low Income ZCTA	16.6%	26.8%	23.6%	43.4%	29.2%	100.0%	28.0%	17.8%
% Rural	18.9%	20.9%	23.3%	13.5%	7.2%	31.7%	100.0%	16.4%
% High Complexity	20.6%	27.7%	30.8%	25.3%	26.9%	22.2%	17.9%	100.0%
Mean Age	80.8	79.5	74.1	77.6	78.8	79.1	80.0	78.6
Median Age	81	79	73	77	79	79	80	78

Patient Characteristics (top 10 Hierarchical Condition Categories)	**All**	**Dual**	**Disabled**	**Black**	**Hispanic**	**Low-Income ZCTA**	**Rural**	**Medically Complex**
% with HCCs (in order of prevalence among all stays)								
HCC80: Congestive Heart Failure	64%	69%	73%	70%	68%	66%	63%	95%
HCC92: Specified Heart Arrhythmias	53%	48%	52%	41%	44%	47%	50%	72%
HCC131: Renal Failure	42%	46%	47%	49%	47%	43%	39%	72%
HCC108: Chronic Obstructive Pulmonary Disease	37%	43%	49%	36%	35%	40%	39%	69%
HCC105: Vascular Disease	34%	38%	37%	34%	39%	34%	30%	52%
HCC19: Diabetes without Complication	21%	22%	24%	23%	21%	23%	25%	19%
HCC79: Cardio-Respiratory Failure and Shock	21%	24%	27%	21%	23%	21%	20%	54%
HCC15: Diabetes with Renal or Peripheral Circulatory Manifestation	17%	23%	25%	25%	33%	19%	13%	38%
HCC83: Angina Pectoris/Old	17%	18%	23%	17%	20%	17%	16%	26%

Myocardial Infarction								
HCC71: Polyneuropathy	17%	20%	24%	19%	23%	18%	15%	38%

3.1.3 Mortality – PN

Patient Characteristics	All	Dual	Disabled	Black	Hispanic	Low-Income ZCTA	Rural	Medically Complex
N Stays	326,213	89,574	52,999	25,212	18,040	52,032	72,534	66,424
% All stays	100.0%	27.5%	16.2%	7.7%	5.5%	16.0%	22.2%	20.4%
% Male	44.8%	34.6%	50.8%	40.5%	44.2%	43.2%	45.8%	49.2%
% Dual	27.5%	100.0%	44.3%	52.1%	62.6%	42.8%	31.0%	36.3%
% Disabled	16.2%	26.2%	100.0%	26.9%	18.2%	22.8%	20.1%	23.7%
% Black	7.7%	14.7%	12.8%	100.0%	0.0%	20.0%	5.5%	10.6%
% Hispanic	5.5%	12.6%	6.2%	0.0%	100.0%	10.0%	2.1%	6.8%
% Low Income ZCTA	16.0%	24.8%	22.4%	41.2%	29.0%	100.0%	28.8%	16.8%
% Rural	22.2%	25.1%	27.5%	15.9%	8.6%	40.1%	100.0%	19.7%
% High Complexity	20.4%	27.0%	29.7%	27.9%	25.1%	21.5%	18.1%	100.0%
Mean Age	80.2	79.5	73.8	78.1	79.2	79.1	79.4	78.6
Median Age	80	79	72	77	79	79	79	78

Patient Characteristics (top 10 Hierarchical Condition Categories)	All	Dual	Disabled	Black	Hispanic	Low-Income ZCTA	Rural	Medically Complex
% with HCCs (in order of prevalence among all stays)								
HCC108: Chronic Obstructive Pulmonary Disease	43%	49%	56%	38%	38%	46%	46%	71%
HCC80: Congestive Heart Failure	36%	43%	43%	42%	38%	38%	37%	76%
HCC92: Specified Heart Arrhythmias	33%	31%	30%	24%	25%	29%	31%	55%

HCC105: Vascular Disease	30%	35%	32%	31%	33%	29%	26%	47%
HCC131: Renal Failure	27%	30%	29%	33%	30%	27%	24%	55%
HCC79: Cardio-Respiratory Failure and Shock	19%	22%	26%	18%	19%	19%	19%	50%
HCC19: Diabetes without Complication	19%	21%	23%	22%	21%	21%	21%	21%
HCC71: Polyneuropathy	15%	17%	20%	17%	19%	15%	13%	32%
HCC83: Angina Pectoris/Old Myocardial Infarction	12%	12%	15%	11%	13%	12%	12%	21%
HCC15: Diabetes with Renal or Peripheral Circulatory Manifestation	10%	14%	14%	18%	22%	12%	8%	25%

3.2 Provider Characteristics, by measure denominator (MSPB, mortality)

3.2.1 Mortality – AMI

Patient Characteristics	All	Major Teaching Hospital	High-DSH	High-SSI	High-Dual	High-Disabled	High-Black	High-Hispanic	Low Income ZCTA	Rural (non-MSA) Hospital	High Medical Complexity
N stays	184,206	33,465	33,118	26,224	17,925	20,931	33,198	35,633	22,272	23,852	21,460
% All stays	100.0%	18.2%	18.0%	14.2%	9.7%	11.4%	18.0%	19.3%	12.1%	12.9%	11.7%
% Male	52.5%	53.4%	51.1%	50.3%	48.4%	50.4%	50.1%	52.1%	50.3%	50.7%	48.2%
% Dual	20.7%	23.2%	34.9%	40.1%	46.4%	30.6%	27.4%	31.3%	32.8%	24.2%	33.7%
% Disabled	14.7%	15.2%	17.0%	16.9%	17.1%	22.7%	17.8%	14.0%	20.5%	17.1%	15.1%
% Black	8.5%	13.9%	17.4%	18.1%	18.5%	16.2%	28.7%	10.0%	17.8%	5.8%	14.6%
% Hispanic	6.0%	6.2%	17.6%	22.4%	24.7%	2.8%	5.5%	23.8%	10.3%	1.6%	15.8%
% Low Income ZCTA	15.7%	17.3%	26.8%	29.6%	31.3%	37.7%	28.8%	16.8%	53.0%	24.7%	21.4%
% Rural	23.1%	17.1%	16.3%	17.0%	20.0%	46.9%	20.1%	7.7%	42.2%	78.3%	13.5%
% High Complexity	20.2%	20.3%	23.6%	25.3%	26.5%	21.6%	23.0%	24.5%	21.9%	19.3%	31.9%
Mean Age	78.5	78.1	78.1	78.5	78.9	77.7	77.8	78.6	77.8	79.0	79.7

Median Age	78	77	77	78	78	77	77	78	77	78	80

Patient Characteristics (top 10 Hierarchical Condition Categories)	All	Major Teaching Hospital	High-DSH	High-SSI	High-Dual	High-Disabled	High-Black	High-Hispanic	Low Income ZCTA	Rural (non-MSA) Hospital	High Medical Complexity
% with HCCs (in order of prevalence among all stays)											
HCC80: Congestive Heart Failure	28%	28%	32%	34%	36%	31%	32%	31%	31%	29%	39%
HCC105: Vascular Disease	27%	27%	29%	31%	32%	25%	28%	31%	26%	23%	36%
HCC131: Renal Failure	24%	24%	27%	29%	30%	25%	26%	29%	25%	23%	33%
HCC108: Chronic Obstructive Pulmonary Disease	23%	21%	24%	25%	27%	27%	23%	23%	27%	26%	29%
HCC92: Specified Heart Arrhythmias	23%	22%	22%	22%	23%	21%	22%	22%	21%	23%	27%
HCC19: Diabetes without Complication	20%	21%	20%	21%	21%	24%	22%	18%	23%	23%	19%
HCC83: Angina Pectoris/Old Myocardial Infarction	14%	13%	14%	14%	15%	13%	13%	16%	14%	12%	16%
HCC71: Polyneuropathy	13%	12%	15%	15%	15%	12%	13%	17%	13%	11%	18%
HCC15: Diabetes with Renal or Peripheral Circulatory Manifestation	12%	13%	16%	18%	18%	10%	14%	19%	12%	9%	19%
HCC79: Cardio-Respiratory Failure and Shock	9%	8%	9%	9%	10%	9%	9%	9%	10%	9%	12%

3.2.2 Mortality – HF

Patient Characteristics	All	Major Teaching Hospital	High-DSH	High-SSI	High-Dual	High-Disabled	High-Black	High-Hispanic	Low Income ZCTA	Rural (non-MSA) Hospital	High Medical Complexity
N stays	335,860	56,611	60,318	50,982	38,034	40,165	67,349	62,819	43,138	50,208	75,029

% All stays	100.0%	16.9%	18.0%	15.2%	11.3%	12.0%	20.1%	18.7%	12.8%	14.9%	22.3%
% Male	45.6%	47.0%	44.7%	43.8%	42.8%	43.9%	44.0%	45.8%	44.0%	44.4%	45.5%
% Dual	25.2%	27.9%	41.7%	46.5%	51.9%	36.6%	32.7%	36.5%	38.8%	29.6%	31.7%
% Disabled	16.3%	17.0%	19.1%	19.0%	19.5%	25.1%	20.2%	15.6%	22.4%	19.4%	16.6%
% Black	12.2%	20.9%	24.2%	24.4%	24.0%	21.6%	36.9%	13.9%	24.4%	8.6%	15.0%
% Hispanic	5.8%	6.3%	17.4%	20.7%	21.8%	3.1%	5.1%	23.3%	9.4%	2.0%	13.6%
% Low Income ZCTA	16.6%	19.8%	30.2%	33.4%	35.9%	39.4%	32.2%	18.5%	56.2%	26.8%	19.3%
% Rural	18.9%	8.1%	14.6%	18.8%	25.9%	46.7%	17.3%	5.6%	42.5%	79.6%	8.7%
% High Complexity	20.6%	22.2%	23.2%	23.9%	23.7%	20.6%	22.0%	24.0%	21.2%	17.5%	27.4%
Mean Age	80.8	80.1	79.8	79.9	80.0	79.3	79.3	80.4	79.5	80.7	80.5
Median Age	81	80	80	80	80	79	79	81	79	81	81

Patient Characteristics (top 10 Hierarchical Condition Categories)	**All**	**Major Teaching Hospital**	**High-DSH**	**High-SSI**	**High-Dual**	**High-Disabled**	**High-Black**	**High-Hispanic**	**Low Income ZCTA**	**Rural (non-MSA) Hospital**	**High Medical Complexity**
% with HCCs (in order of prevalence among all stays)											
HCC80: Congestive Heart Failure	64%	67%	67%	67%	67%	65%	67%	66%	65%	62%	68%
HCC92: Specified Heart Arrhythmias	53%	53%	48%	47%	46%	48%	49%	50%	47%	50%	53%
HCC131: Renal Failure	42%	44%	44%	44%	43%	42%	43%	45%	42%	39%	46%
HCC108: Chronic Obstructive Pulmonary Disease	37%	33%	37%	38%	39%	41%	36%	36%	40%	39%	40%
HCC105: Vascular Disease	34%	36%	36%	36%	36%	31%	34%	38%	33%	30%	40%
HCC19: Diabetes without Complication	21%	21%	21%	21%	22%	25%	23%	19%	24%	24%	20%
HCC79: Cardio-Respiratory Failure and Shock	21%	21%	21%	21%	20%	20%	20%	21%	21%	20%	23%
HCC15: Diabetes with Renal or Peripheral Circulatory Manifestation	17%	19%	22%	23%	22%	15%	19%	25%	17%	13%	23%

HCC83: Angina Pectoris/Old Myocardial Infarction	17%	17%	17%	17%	17%	17%	17%	19%	17%	16%	19%
HCC71: Polyneuropathy	17%	16%	18%	18%	18%	16%	17%	20%	17%	15%	20%

3.2.3 Mortality – PN

Patient Characteristics	All	Major Teaching Hospital	High-DSH	High-SSI	High-Dual	High-Disabled	High-Black	High-Hispanic	Low Income ZCTA	Rural (non-MSA) Hospital	High Medical Complexity
N stays	326,213	40,782	52,842	47,451	39,603	46,230	54,110	56,051	46,087	66,516	67,848
% All stays	100.0%	12.5%	16.2%	14.5%	12.1%	14.2%	16.6%	17.2%	14.1%	20.4%	20.8%
% Male	44.8%	45.3%	44.0%	43.9%	43.5%	44.0%	43.2%	45.1%	43.9%	44.9%	44.6%
% Dual	27.5%	29.8%	44.2%	48.5%	53.8%	38.9%	34.5%	38.8%	39.9%	32.2%	32.7%
% Disabled	16.2%	15.5%	18.0%	18.5%	19.6%	25.1%	19.1%	14.6%	22.4%	19.8%	16.6%
% Black	7.7%	14.3%	15.3%	15.2%	14.5%	12.6%	26.4%	8.8%	14.2%	5.3%	11.9%
% Hispanic	5.5%	7.1%	17.9%	20.1%	19.3%	2.6%	5.0%	23.9%	8.3%	2.1%	11.6%
% Low Income ZCTA	16.0%	17.0%	28.8%	32.8%	36.8%	39.2%	30.5%	17.1%	55.4%	27.4%	17.5%
% Rural	22.2%	6.5%	19.2%	25.6%	36.5%	52.9%	21.9%	7.1%	50.0%	79.8%	9.9%
% High Complexity	20.4%	23.4%	23.0%	23.0%	22.1%	19.7%	21.8%	23.7%	19.9%	17.1%	27.3%
Mean Age	80.2	80.1	79.8	80.0	80.0	78.9	79.4	80.4	79.2	79.9	80.0
Median Age	80	80	80	80	80	78	79	81	79	80	80

Patient Characteristics (top 10 Hierarchical Condition Categories)	All	Major Teaching	High-DSH	High-SSI	High-Dual	High-Disabled	High-Black	High-Hispanic	Low Income ZCTA	Rural (non-MSA) Hospital	High Medical Complexity
% with HCCs (in order of prevalence among all stays)											

HCC108: Chronic Obstructive Pulmonary Disease	43%	38%	42%	42%	44%	47%	41%	40%	46%	45%	45%
HCC80: Congestive Heart Failure	36%	38%	38%	39%	39%	38%	37%	38%	37%	36%	41%
HCC92: Specified Heart Arrhythmias	33%	33%	30%	29%	28%	30%	30%	31%	29%	31%	34%
HCC105: Vascular Disease	30%	31%	31%	31%	31%	26%	29%	34%	27%	26%	35%
HCC131: Renal Failure	27%	29%	28%	28%	28%	26%	27%	30%	26%	24%	31%
HCC79: Cardio-Respiratory Failure and Shock	19%	18%	18%	17%	17%	19%	18%	19%	18%	18%	21%
HCC19: Diabetes without Complication	19%	18%	20%	20%	21%	23%	21%	18%	22%	21%	19%
HCC71: Polyneuropathy	15%	14%	15%	15%	14%	13%	15%	17%	14%	12%	17%
HCC83: Angina Pectoris/Old Myocardial Infarction	12%	11%	11%	12%	12%	12%	11%	12%	12%	11%	13%
HCC15: Diabetes with Renal or Peripheral Circulatory Manifestation	10%	12%	13%	14%	13%	9%	11%	16%	10%	7%	14%

4. MSPB

- **Table 4.1 MSPB: Patients' Dual Status and Medical Complexity on MSPB Spending for Safety-Net and Teaching Hospitals**

The first model shows the effect of patient dual status and medical complexity separately and in the same regression model. Duals continue to have higher spending even after adjusting for potentially unmeasured medical complexity using HCC risk scores. However the 2% higher spending for medically complex patients (patients in top 20% of HCC scores) is reduced to 1% after adjusting for dual status.

The second and third models show how higher spending for safety-net hospitals and teaching hospitals is reduced to zero after adjusting for patient dual and medical complexity.

Variables		Risk-adjustment without SES factors			
		Coefficients from separate models*		Coefficients from same model*	
		Beta	*p-value*	*Beta*	*p-value*
Model 1	dual	**0.04**	<.0001	**0.04**	<.0001
	complex	**0.02**	0.0011	**0.01**	<.0001
Model 2	dual	**0.04**	<.0001	**0.04**	<.0001
	complex	**0.02**	0.0011	**0.01**	<.0001
	top 20% DSH	**0.01**	0.0009	0.00	0.8540
Model 3	dual	**0.04**	<.0001	**0.04**	<.0001
	complex	**0.02**	0.0011	**0.01**	<.0001
	teaching hospital	0.01	0.1533	0.00	0.3475

* Random effects regression models

- **Table 4.2. MSPB: Effect of Medical Risk on MSPB Spending**

This table examines how MSPB spending varies by patients' medical risk to understand if unmeasured medical risk - using HCC risk scores quintiles - may partly explain higher spending. It shows lower risk patients (first and second risk quintiles) have about 1% lower spending than the average risk patient, whereas high risk patients (fourth and fifth risk quintiles) have about 1% higher spending than the average risk patient. This suggests the measure's current risk-adjustment model may not completely account for spending due to medical risk. The next table then explores if dual effect varies by medical risk quintiles.

Variables	Average Episode Ratio	Effect of Medical Risk on MSPB Spending	
		Beta	*p-value*
Risk Quintile 1: 1st-20th percentile	0.9843	**-0.014**	<.0001
Risk Quintile 2: 21st-40th percentile	0.9856	**-0.015**	<.0001
Risk Quintile 3: 41st-60th percentile*	1.0027		
Risk Quintile 4: 61st-80th percentile	1.0119	**0.008**	<.0001

Risk Quintile 5: 81st-100th percentile	1.0203	**0.014**	<.0001

*Risk quintile 3 was the reference group

- **Table 4.3. MSPB: Dual Effect by HCC Risk Score Quintiles**

Table 4.3 shows a consistent dual effect for patients with different medical risk based on HCC risk score quintiles, with a stronger dual effect for lower medical risk beneficiaries (i.e. 7% higher spending for beneficiaries in the first risk quintile) compared with the higher risk beneficiaries (3% higher spending). After adjusting for patients' medical risk using HCC risk quintiles, the higher spending observed in high-dual hospitals (1-2% higher spending) also is diminished to zero or not statistically significant.

Variables		**Dual Effect by Patient Medical Risk Quintiles**			
		Coefficients from separate models*		**Coefficients from same model***	
		Beta	*p-value*	*Beta*	*p-value*
Risk Quintile 1: 1st-20th percentile	Dual	**0.07**	0.0000	**0.07**	0.0000
	High-Dual hospital	**0.02**	0.0000	0.00	0.1926
Risk Quintile 2: 21st-40th percentile	Dual	**0.06**	0.0000	**0.06**	0.0000
	High-Dual hospital	**0.01**	0.0240	**-0.01**	0.0129
Risk Quintile 3: 41st-60th percentile	Dual	**0.04**	0.0000	**0.04**	0.0000
	High-Dual hospital	**0.01**	0.0212	-0.01	0.2104
Risk Quintile 4: 61st-80th percentile	Dual	**0.03**	0.0000	**0.03**	0.0000
	High-dual hospital	0.01	0.1127	0.00	0.3208
Risk Quintile 5: 81st-100th percentile	Dual	**0.03**	0.0000	**0.03**	0.0000
	High-Dual hospital	**0.02**	0.0001	0.01	0.0707

* Random effects regression models

- **Table 4.4. MSPB: Dual effect across Major Diagnostic Categories (MDC)**

Table 4.4 supports figure 7.2 in the HVBP chapter, and shows consistently higher spending for duals across most of the 27 Major Diagnostic Categories (MDC) used to calculate a hospitals average spending in the MSPB measure. On average duals spend 4% more than non-dual beneficiaries for hospital-related episode, but this ranges from 0-10% higher spending across the MDCs. High-dual hospitals also have higher spending across the MDCs, which is reduced after adjusting for patients' dual status.

Variables		Total population in MDC	group size	% among total population in MDC	Dual Effect on MSPB Spending			
					Coefficient from separate models*		Coefficient from same model	
					Beta	*p-value*	*Beta*	*p-value*
Across all MDCs	Dual	3,582,596	1,162,677	32.45%	**0.04**	<.0001	**0.04**	<.0001
	High-Dual hospital		396,130	11.06%	**0.01**	0.001	0.00	0.805
MDC 1: Dis of Nervous System	Dual	292,965	90,624	30.93%	**0.06**	0.000	**0.06**	0.000
	High-Dual hospital		29,762	10.16%	**0.03**	0.000	**0.01**	0.026
MDC 2: Dis of Eye	Dual	4,611	1,532	33.22%	**0.09**	0.000	**0.10**	0.000
	High-Dual hospital		584	12.67%	-0.03	0.253	**-0.06**	0.042
MDC 3: Dis of Ear, Nose, Mouth, Throat	Dual	26,071	8,166	31.32%	**0.05**	0.000	**0.05**	0.000
	High-Dual hospital		3,437	13.20%	-0.01	0.456	-0.03	0.044
MDC 4: Dis of Respiratory System	Dual	438,586	163,883	37.37%	**0.05**	0.000	**0.05**	0.000
	High-Dual hospital		55,716	12.71%	**0.02**	0.000	0.00	0.678
MDC 5: Dis of Circulatory System	Dual	728,466	205,598	28.22%	**0.05**	0.000	**0.05**	0.000
	High-Dual hospital		76,055	10.44%	0.01	0.159	**-0.01**	0.007
MDC 6: Dis of Digestive System	Dual	397,683	119,231	29.98%	**0.05**	0.000	**0.05**	0.000
	High-Dual hospital		41,530	10.45%	**0.01**	0.014	0.00	0.240
MDC 7: Dis of Hepatobiliary System	Dual	96,962	33,400	34.45%	**0.03**	0.000	**0.03**	0.000
	High-Dual hospital		11,467	11.83%	0.00	0.940	-0.01	0.094
MDC 8: Dis of Musculoskeletal/Connective	Dual	563,159	112,527	19.98%	**0.05**	0.000	**0.05**	0.000
	High-Dual hospital		37,052	6.59%	**0.03**	0.000	0.01	0.055
MDC 9: Dis of Skin	Dual	104,839	39,803	37.97%	**0.06**	0.000	**0.06**	0.000
	High-Dual hospital		14,018	13.38%	**0.02**	0.018	0.00	0.925
MDC 10: Dis of Endocrine	Dual	129,712	56,289	43.40%	**0.04**	0.000	**0.04**	0.000
	High-Dual hospital		19,041	14.69%	0.01	0.237	0.00	0.696
MDC 11: Dis of Kidney and Urinary	Dual	281,987	106,835	37.89%	**0.05**	0.000	**0.05**	0.000
	High-Dual hospital		35,034	12.43%	0.00	0.986	**-0.01**	0.006

Variables		Total population in MDC	group size	% among total population in MDC	Dual Effect on MSPB Spending			
					Coefficient from separate models*		Coefficient from same model	
					Beta	*p-value*	*Beta*	*p-value*
Tract								
MDC 12: Dis of Male Reproductive System	Dual	17,983	3,481	19.36%	**0.05**	0.000	**0.06**	0.000
	High-Dual hospital		1,897	10.55%	0.00	0.964	-0.02	0.115
MDC 13: Dis of Female Reproductive System	Dual	23,972	7,739	32.28%	**0.04**	0.000	**0.04**	0.000
	High-Dual hospital		2,357	9.84%	-0.01	0.629	-0.02	0.056
MDC 14: Pregnancy, Childbirth	Dual	8,275	7,816	94.45%	0.00	0.935	0.00	0.997
	High-Dual hospital		1,224	14.81%	**-0.05**	0.000	**-0.05**	0.000
MDC 16: Dis of Blood	Dual	56,089	21,372	38.10%	**0.01**	0.008	**0.02**	0.002
	High-Dual hospital		8,035	14.33%	-0.01	0.095	**-0.02**	0.022
MDC 17: Myeloproliferative DDs	Dual	17,953	4,076	22.70%	**-0.04**	0.000	**-0.04**	0.000
	High-Dual hospital		1,329	7.41%	**-0.06**	0.000	**-0.05**	0.002
MDC 18: Infectious and Parasitic DDs	Dual	210,468	85,986	40.85%	**0.04**	0.000	**0.04**	0.000
	High-Dual hospital		25,812	12.27%	**0.04**	0.000	**0.03**	0.000
MDC 19: Mental Diseases and Disorders	Dual	47,706	33,705	70.65%	**0.07**	0.000	**0.07**	0.000
	High-Dual hospital		12,406	26.01%	0.02	0.212	0.01	0.743
MDC 20: Alcohol/Drug Use	Dual	23,518	14,289	60.76%	**0.05**	0.000	**0.05**	0.000
	High-Dual hospital		5,791	24.62%	-0.03	0.100	**-0.04**	0.026
MDC 21: Injuries, Poison, Toxic Effects Drugs	Dual	47,409	21,057	44.42%	**0.04**	0.000	**0.04**	0.000
	High-Dual hospital		5,244	11.07%	**0.02**	0.021	0.01	0.180
MDC 22: Burns	Dual	1,458	674	46.23%	**0.10**	0.001	**0.10**	0.001
	High-Dual hospital		258	17.71%	0.07	0.144	0.07	0.152
MDC 23: Health Status/Other Contacts	Dual	21,552	8,387	38.92%	**0.03**	0.001	**0.03**	0.003
	High-Dual hospital		3,042	14.25%	**0.03**	0.041	0.02	0.162
MDC 24: Multiple Significant	Dual	4,586	1,173	25.58%	0.00	0.884	0.00	0.842
	High-Dual		422	9.21%	0.01	0.708	0.01	0.687

Variables		Total population in MDC	group size	% among total population in MDC	Dual Effect on MSPB Spending			
					Coefficient from separate models*		Coefficient from same model	
					Beta	*p-value*	*Beta*	*p-value*
Trauma	hospital							
MDC 25: HIV Infection	Dual	3,748	3,033	80.92%	0.04	0.119	0.04	0.119
	High-Dual hospital		996	26.58%	0.00	0.994	0.00	0.896
MDC F	Dual	20,668	7,059	34.15%	**0.03**	0.000	**0.03**	0.000
	High-Dual hospital		2,231	10.80%	**0.04**	0.001	**0.03**	0.012
MDC PRE	Dual	12,170	4,942	40.61%	**0.03**	0.000	**0.03**	0.000
	High-Dual hospital		1,390	11.43%	0.01	0.152	0.01	0.580

Bolded are significant at p<0.05

** No results for MDC 15 (newborn and neonates) as observations too low.

- **Table 4.5-4.6. MSPB: Standardized spending and differences in actual-minus-predicted spending by setting**

Table 4.5 shows the average standardizing spending amount by setting for duals and non-duals among all episodes, that reflects differences in both patients' utilization of the setting and intensity of services for patients who receive care in that setting. However the standardized spending amount does not incorporate the MSPB measure's risk-adjustment, which compares actual standardized spending to predicted spending. The next table 4.6 looks at differences in actual-minus-predicted spending to determine if there are still differences by dual status after incorporating the measure's risk-adjustment.

Table 4.5 MSPB Average Standardized Spending by Setting, All Episodes

Setting Type	Average standardized spending amount, all MSPB episodes		
	dual	*non-dual*	*difference*
Total episode spending	$19,842	$19,483	$359
Pre-index (3 days)	$701	$601	$100
Index admission	$9,857	$10,954	-$1,097
Post-acute Total	$9,284	$7,927	$1,356
Post-acute IP	$2,966	$2,439	$527
Post-acute SNF	$3,486	$2,838	$648
Post-acute HHA	$602	$810	-$208
Post-acute OP	$804	$604	$200
Post-acute HS	$123	$113	$10
Post-acute DM	$120	$97	$23

Post-acute PB	$1,183	$1,026	$157

Table 4.6 MSPB: Differences in Actual-minus-Predicted Spending by Setting, All Episodes

Tables 4.6 show

Table 4.6.1 Differences in Utilization by Dual Status, by Setting Type

Setting Type	Proportion of group that utilizes setting, all episodes		
	dual	*non-dual*	*difference*
Total episode spending	100.0%	100.0%	0.0%
Pre-index (3 days)	92.9%	87.0%	5.9%
Index admission	100.0%	100.0%	0.0%
Post-acute Total	96.5%	96.8%	-0.3%
Post-acute IP	22.6%	18.1%	4.5%
Post-acute SNF	24.9%	21.9%	3.0%
Post-acute HHA	21.4%	27.8%	-6.4%
Post-acute OP	57.9%	53.7%	4.2%
Post-acute HS	2.3%	2.1%	0.1%
Post-acute DM	29.3%	25.2%	4.1%
Post-acute PB	92.5%	93.4%	-0.9%

Table 4.6.2 Differences in Actual Standardized Spending and Predicted Spending by Dual Status, by Setting Type (all episodes)

Setting Type	Average Standardized Spending		Average Predicted Spending		Average Difference (standardized spending-predicted spending)	
	dual	*non-dual*	*dual*	*non-dual*	*dual*	*non-dual*
Total episode spending	$19,842	$19,483	$19,395	$19,696	**$447**	**-$213**
Pre-index (3 days)	$701	$601	$684	$609	$17	-$8
Index admission	$9,857	$10,954	$9,870	$10,948	-$13	$6
Post-acute Total	$9,284	$7,927	$8,788	$8,164	$496	-$236
Post-acute IP	$2,966	$2,439	$2,944	$2,450	$22	-$10
Post-acute SNF	$3,486	$2,838	$3,019	$3,061	$467	-$223
Post-acute HHA	$602	$810	$581	$820	$20	-$10
Post-acute OP	$804	$604	$822	$596	-$18	$8
Post-acute HS	$123	$113	$120	$114	$3	-$1

Post-acute DM	$120	$97	$121	$96	-$1	$1
Post-acute PB	$1,183	$1,026	$1,180	$1,027	$3	-$1

Table 4.6.2 Dual Effect on Actual-to-Predicted MSPB Spending, by Setting Type (beta is the difference between duals and non-duals of the Differences in Average Actual Standardized Spending and Predicted Spending)

Setting Type	Regression Results for Difference*	
	beta	*p-value*
Total episode spending	**718.4**	0.000
Pre-index (3 days)	**36.3**	0.000
Index admission	-1.3	0.680
Post-acute Total	**732.3**	0.000
Post-acute IP	**-47.0**	0.000
Post-acute SNF	**758.4**	0.000
Post-acute HHA	**16.8**	0.000
Post-acute OP	**-15.0**	0.000
Post-acute HS	**8.6**	0.000
Post-acute DM	**-1.9**	0.008
Post-acute PB	**9.3**	0.000

*Model was adjusted for MDC to account for variation of cost across MDCs
Legend: Post-acute acute IP includes acute readmissions or stays in an inpatient rehabilitation facility within the 30-day episode period. SNF= skilled nursing facility, HHA = home health agency, OP = outpatient facility care, HS= hospice services, DM= durable medical equipment, PB = physician billing

- **4.7 MSPB: Differences in Actual-to-Predicted Spending Across Settings, For All Other Social Risk Factors (Blacks, Hispanics, Rural, Medically Complex)**

Table 4.7 examines the difference in actual-predicted MSPB spending by patient group and estimates the effect of patient social risk on that difference for each of the social risk factors. For example, dual patients on average spend $447 more than predicted for duals, while non-dual patients spend $213 less than predicted, resulting in a difference of $718 between duals and non-duals in the actual-predicted spending. In other words, duals have $718 higher actual-predicted spending than non-duals. This effect is highest for duals, followed by medical complex patients (beta: $272). This suggests that the risk-adjustment model may underestimate the spending in duals and medically complex patients.

Additional tables present these actual-predicted spending differences for each social risk factor across the settings, to help understand what may be the drivers of spending. Duals and Blacks appear to have higher difference in actual-predicted spending due to greater use of post-acute care, in particular skilled nursing facilities, whereas Hispanics have lower actual-predicted spending than non-Hispanics primarily due to lower use and lower spending in skilled nursing and inpatient settings for post-acute care.

Patients from low-income ZCTA-level neighborhoods also had slightly higher actual-predicted spending due to slightly higher post-acute care spending, mainly for skilled nursing and home health. Rural patients have higher spending due to greater actual-predicted spending for pre-index care as well as post-acute outpatient care. Medically complex patients have higher actual-predicted spending due to higher than expected spending for post-acute care in inpatient settings and skilled nursing.

Table 4.7 Effect of Patient Social Risk on Actual-Predicted MSPB Spending, All Social Risk Factors

Patient Social Risk Factor	Average Standardized Spending, all episodes			Average Predicted Spending		Average Difference (standardized spending- predicted spending)		Effect of Social Risk on Difference in Actual-Predicted Spending*	
	High social risk patient	*Other*	*difference*	*High social risk patient*	*Other*	*High social risk patient*	*Other*	*beta*	*p-value*
Dual	$19,842	$19,483	$359	$19,395	$19,696	$447	-$213	**$718**	0.000
Low-income ZCTA	$19,233	$19,673	-$440	$19,247	$19,670	-$13	$4	**$53**	*0.0007*
Black	$19,769	$19,607	$162	$19,605	$19,620	$164	-$14	**$89**	*<.0001*
Hispanic	$19,424	$19,639	-$215	$19,640	$19,617	-$216	$22	**-$740**	<.0001
Rural	$19,074	$19,741	-$667	$19,486	$19,629	-$412	$112	**$135**	<.0001
Medically Complex	$22,860	$18,808	$4,052	$22,605	$18,867	$255	-$59	**$273**	<.0001

Table 4.7.1 Duals

Setting Type	Proportion of group that utilizes setting	Average Difference (standardized spending- predicted spending)		Regression Results for Difference*	
	difference	*dual*	*non-dual*	*beta*	*p-value*
Total episode spending	0.0%	$447	-$213	**718**	0.000
Pre-index (3 days)	5.9%	$17	-$8	**36**	0.000
Index admission	0.0%	-$13	$6	-1	0.680
Post-acute Total	-0.3%	$496	-$236	**732**	0.000
Post-acute IP	4.5%	$22	-$10	**-47**	0.000
Post-acute SNF	3.0%	$467	-$223	**758**	0.000
Post-acute HHA	-6.4%	$20	-$10	**17**	0.000
Post-acute OP	4.2%	-$18	$8	**-15**	0.000
Post-acute HS	0.1%	$3	-$1	**9**	0.000

Post-acute DM	4.1%	-$1	$1	**-2**	0.008
Post-acute PB	-0.9%	$3	-$1	**9**	0.000

*Bolded values are statistically significant at p<0.001

Table 4.7.2 Low-income ZCTA

Setting Type	Proportion of group that utilizes setting	Average Difference (standardized spending- predicted spending)		Regression Results for Difference*	
	difference	*low-income*	*non-low-income*	*beta*	*p-value*
Total episode spending	0.0%	-$13	$4	**53**	0.0007
Pre-index (3 days)	1.9%	$6	-$1	**13**	<.0001
Index admission	0.0%	-$58	$12	3	0.4805
Post-acute Total	-0.8%	$94	-$18	**75**	<.0001
Post-acute IP	2.4%	$186	-$38	18	0.0846
Post-acute SNF	-3.7%	-$88	$19	**58**	<.0001
Post-acute HHA	-1.5%	$43	-$9	**30**	<.0001
Post-acute OP	3.1%	-$21	$4	**-9**	0.0006
Post-acute HS	0.0%	$8	-$2	1	0.6348
Post-acute DM	3.8%	$3	-$1	-1	0.3611
Post-acute PB	-2.0%	-$37	$8	**-21**	<.0001

*Bolded values are statistically significant at p<0.001

Table 4.7.3 Black

Setting Type	Proportion of group that utilizes setting	Average Difference (standardized spending- predicted spending)		Effect of Social Risk on Difference in Actual-Predicted Spending*	
	Utilization difference (	*Black*	*non-Black*	*beta*	*p-value*
Total episode spending	0.0%	$164	-$14	**90**	<.0001

Pre-index (3 days)	3.5%	-$46	$7	**-46**	<.0001
Index admission	0.0%	$26	-$2	5	0.273
Post-acute Total	-1.5%	$308	-$40	**230**	<.0001
Post-acute IP	4.1%	$191	-$26	**42**	0.000
Post-acute SNF	-4.6%	$72	-$8	**167**	<.0001
Post-acute HHA	-1.7%	$80	-$10	**61**	<.0001
Post-acute OP	3.7%	-$55	$7	**-28**	<.0001
Post-acute HS	-0.3%	$0	$0	**-4**	0.021
Post-acute DM	1.7%	$0	$0	**-4**	0.000
Post-acute PB	-1.9%	$20	-$2	**-8**	0.002

*Bolded values are statistically significant at p<0.001

Table 4.7.4 Hispanics

Setting Type	Proportion of group that utilizes setting	Average Difference (standardized spending- predicted spending)		Effect of Social Risk on Difference in Actual-Predicted Spending*	
	Utilization difference	*Hispanic*	*non-Hispanic*	*beta*	*p-value*
Total episode spending	0.0%	-$216	$22	**-740**	<.0001
Pre-index (3 days)	2.6%	-$44	$3	**-38**	<.0001
Index admission	0.0%	$53	-$2	**-31**	<.0001
Post-acute Total	-0.7%	-$164	$13	**-595**	<.0001
Post-acute IP	1.8%	$126	-$8	**-183**	<.0001
Post-acute SNF	-5.8%	-$331	$23	**-380**	<.0001
Post-acute HHA	0.4%	$92	-$5	**46**	<.0001
Post-acute OP	-1.1%	-$77	$4	**-16**	0.000
Post-acute HS	-0.4%	$1	$0	**6**	0.011
Post-acute DM	3.0%	$3	$0	3	0.051
Post-acute PB	-1.2%	$23	-$1	**-83**	<.0001

*Bolded values are statistically significant at p<0.001

Table 4.7.5 Rural

Setting Type	Proportion of group that utilizes setting	Average Difference (standardized spending- predicted spending)		Effect of Social Risk on Difference in Actual-Predicted Spending*	
	Utilization difference	*Rural*	*non-Rural*	*beta*	*p-value*
Total episode spending	0.0%	-$412	$112	**136**	<.0001
Pre-index (3 days)	-2.3%	$129	-$35	**307**	<.0001
Index admission	0.0%	-$145	$39	**33**	<.0001
Post-acute Total	-0.2%	-$385	$104	**-157**	<.0001
Post-acute IP	-1.9%	-$164	$44	**-148**	<.0001
Post-acute SNF	-2.0%	-$103	$28	-6	0.575
Post-acute HHA	-3.3%	-$71	$19	**-38**	<.0001
Post-acute OP	11.5%	$111	-$30	**115**	<.0001
Post-acute HS	-0.1%	$2	$0	**-8**	<.0001
Post-acute DM	3.9%	$7	-$2	**9**	<.0001
Post-acute PB	-2.8%	-$167	$45	**-66**	<.0001

*Bolded values are statistically significant at p<0.001

Table 4.7.6 Medically Complex

Setting Type	Proportion of group that utilizes setting	Average Difference (standardized spending- predicted spending)		Effect of Social Risk on Difference in Actual-Predicted Spending*	
	Utilization difference	*Complex*	*non-Complex*	*beta*	*p-value*
Total episode spending	0.0%	$255	-$59	**273**	<.0001
Pre-index (3 days)	7.6%	$10	-$2	**14**	<.0001
Index admission	0.0%	$21	-$5	2	0.555

Post-acute Total	2.8%	$341	-$82	**341**	<.0001
Post-acute IP	11.2%	$153	-$38	**140**	<.0001
Post-acute SNF	4.5%	$68	-$16	**70**	<.0001
Post-acute HHA	0.8%	$50	-$12	**51**	<.0001
Post-acute OP	10.9%	-$6	$1	2	0.314
Post-acute HS	1.7%	$8	-$2	**13**	<.0001
Post-acute DM	14.9%	$17	-$4	**22**	<.0001
Post-acute PB	4.4%	$50	-$12	**41**	<.0001

*Bolded values are statistically significant at p<0.001

- **MSPB: Regression Model Fit Statistics**

To assess if adding dual and/or medical complexity using quintiles of HCC scores from the Medicare RAPS file (based on a one-year look back of Medicare claims) improved the regression model fit, R squared fit statistics are presented in table 4.8 below. They results show that adding these factors to the measure's current risk-adjustment model does not substantially change the model fit.

Table 4.8 FY 2016- Overall R-squared for MSPB, after adding social or related risk factors

Risk-Adjustment Option*	Overall R-Squared	
	Baseline Period	Performance Period
Original (no additions)	0.4508	0.4517
Dual	0.4515	0.4523
Medical Risk Quintile	0.4513	0.4523
Dual + Medical Risk Quintile	0.4519	0.4528

- **MSPB ratios and scores by safety-net, box plots and distribution statistics (FY16)**

The following figures (A-D) show the MSPB measure performance distribution in FY 2016 by safety-net status, and compared to the national median which is the achievement score threshold for the MSPB measure. Safety-net hospitals on average have slightly higher MSPB spending ratio which results in slightly more safety-net hospitals receiving a zero score for the measure.

Figure A. Distribution of MSPB measure (FY2016), proportion of hospitals

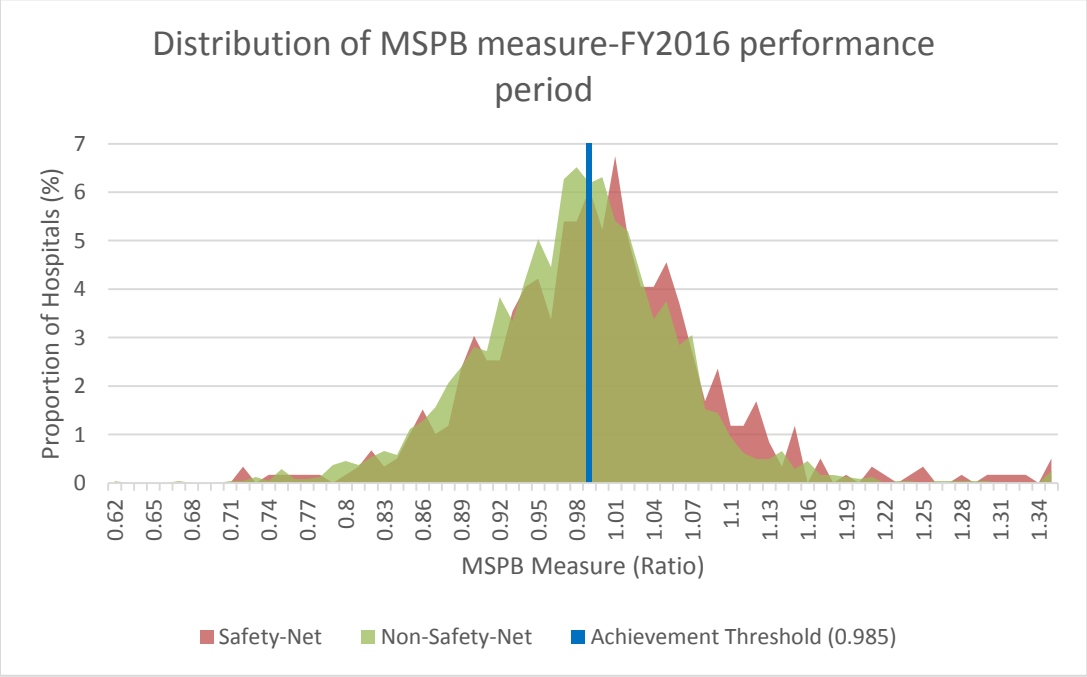
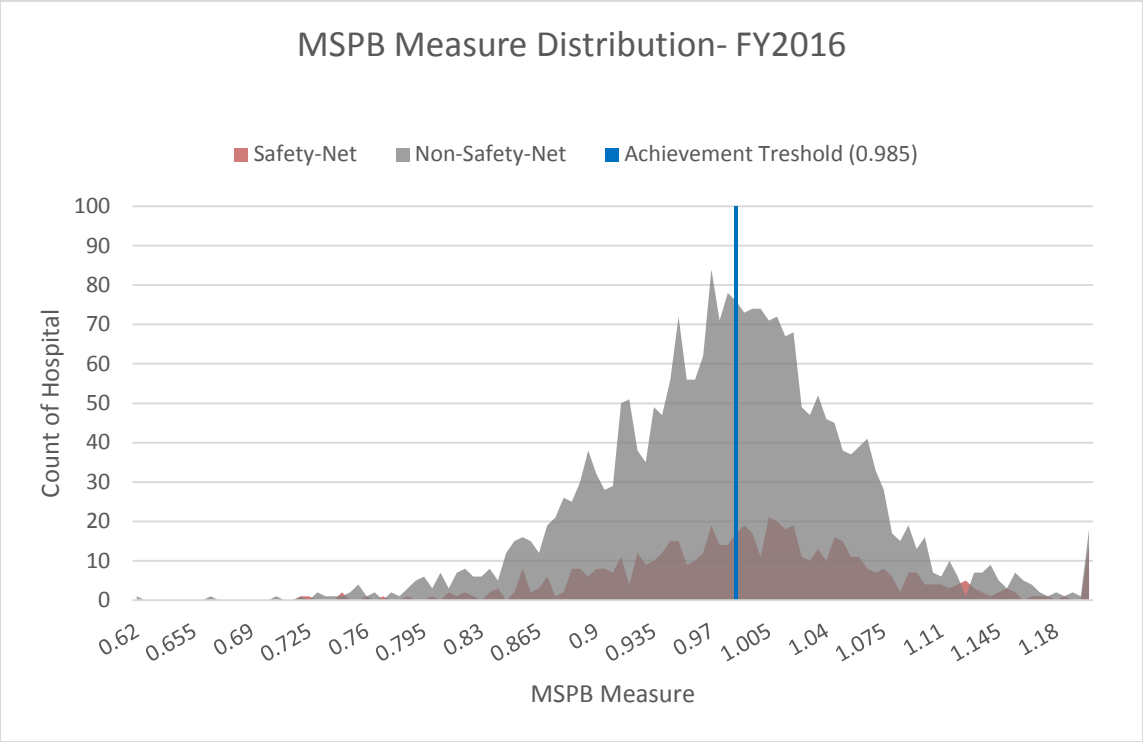
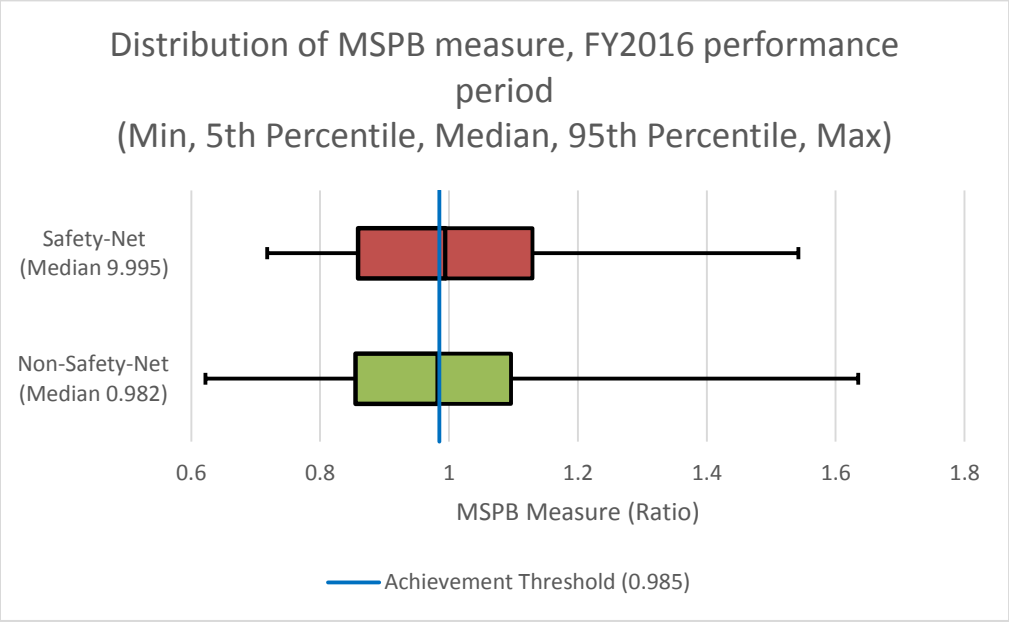


Figure B. Distribution of MSPB measure (FY2016), count of hospitals



05/02/2016 workbook

Figure C. Box Plot Distribution of MSPB measure (FY2016) with distribution statistics

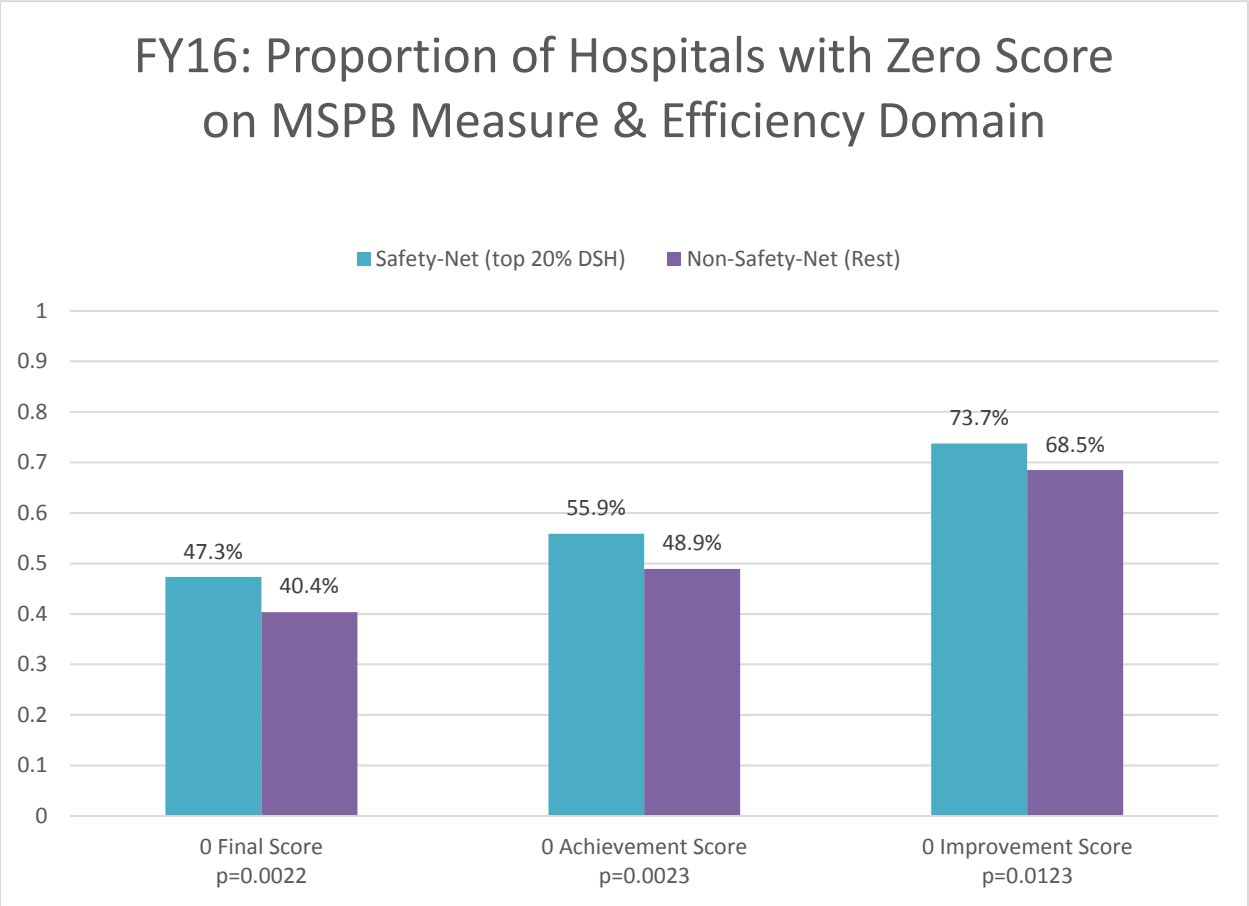


Statistic	Non-Safety-Net	Safety-Net
Minimum	0.62	0.72
5th Percentile	0.86	0.86
25th Percentile	0.94	0.94
Median	0.98	0.99
75th Percentile	1.03	1.04
95th Percentile	1.10	1.13
Maximum	1.63	1.54

- **Proportion of Hospitals who scored Zero on MSPB Measure and Efficiency Domain (FY 2016)**

This next figure shows the proportion of hospitals who did not meet the MSPB measure's threshold to be scored on the measure in FY 2016 and therefore were not eligible for any achievement points for the measure (scores start from 1 at the threshold performance up to 10). The MSPB measure's threshold is defined the median performance on the MSPB measure. A higher proportion of safety-net hospitals received zero achievement points on the MSPB measure, and a higher proportion also did not receive an improvement score, resulting in a higher proportion of safety-net hospitals with zero final score for the measure and the Efficiency domain.

Figure D. Proportion of Hospitals with Zero Score on MSPB Measure (FY 2016)



5. Frailty:

Purpose: These analyses examine if frailty-related conditions may partly explain the observed higher spending in dual patients. Analysis included frailty indicators in MSPB measure risk-adjustment then re-estimated the effect of duals on MSPB episode spending.

Findings:
Abnormality of gait, muscle weakness, difficulty in walking and debility were the most prevalent frailty-related conditions (Table 5.1). Nearly a quarter of Medicare beneficiaries in the MSPB measure had at least one of the twelve frailty-related conditions, and 12% had two or more frailty conditions (Table 5.2). In general, the betas for each individual frailty indicator were positive across the 25 MDCs and on average, indicating higher spending associated with frailty-related conditions.

Table 5.1 Prevalence of Frailty-Associated Conditions in MSPB Measure
(HVBP FY 2016 baseline and performance periods)

Frailty Indicators	% of episodes		Reference (% of benes)
	baseline	performance	
Abnormality of gait	14.0%	15.1%	10.5%
Protein-Calorie Malnutrition	7.0%	6.8%	2.0%
Adult failure to thrive	2.1%	2.1%	1.0%
Cachexia	0.9%	1.0%	0.3%
Debility	6.9%	8.0%	3.3%
Difficulty in walking	9.1%	9.8%	7.7%
Fall	5.1%	6.7%	4.3%
Muscular wasting and disuse atrophy	2.3%	2.3%	1.6%
Muscle weakness	12.2%	14.2%	10.1%
Decubitus ulcer of skin	5.5%	5.6%	1.9%
Senility without mention of psychosis	0.5%	0.5%	0.3%
Durable medical equipment (cane, walker, bath equipment, and commode)	9.7%	8.0%	4.4%

Table 5.2 Distribution of Frailty Indicator- FY2016 baseline and performance periods

Number of Frailty Indicators	% of episodes		Reference (% of benes)
	baseline	performance	
0	62.4%	61.4%	77.0%
1	18.0%	17.8%	10.7%
2	9.4%	9.6%	5.7%
3	5.3%	5.7%	3.3%
4	2.8%	3.1%	1.9%
5	1.3%	1.5%	0.9%
6	0.5%	0.6%	0.4%

Number of Frailty Indicators	% of episodes		Reference (% of benes)
7	0.2%	0.2%	0.1%
8	0.1%	0.1%	0.0%
9	0.0%	0.0%	0.0%
10	0.0%	0.0%	0.0%
11	0.0%	0.0%	0.0%
12	0.0%	0.0%	0.0%

Table 5.3 shows that after adjusting for frailty as an index or as separate covariates in the MSPB measure's risk-adjustment model, the observed higher spending decreased from 4.5% to 4%, about a 12% decrease. These results support the hypothesis that unmeasured medical comorbidity or risk such as patient frailty could partly explain the observed 4.5% higher spending in dually eligible beneficiaries. There may be other relevant patient medical conditions that explain variation in Medicare spending around an inpatient episode and which are co-related to social risk such as dual status, which could be considered to be included in the risk-adjustment model of cost measures such as MSPB. This analysis is meant to be illustrative only. Further work will be undertaken in Study B to examine factors such as functional status, cognitive impairment and other frailty-related conditions that could explain increased used of institutional post-acute care settings that are appropriate to improve the measure's risk-adjustment model.

Table 5.3 MSPB episode ratio for dual, before and after adding frailty index or frailty indicators to the MSPB measure risk adjustment, FY2016 performance period

Patient SES Factor	Current Risk-adjustment Methodology					
	Average episode ratio		GEE Model		RE Model	
	Dual	Non-Dual	Beta	p-value	Beta	p-value
Dual Eligible	1.03	0.98	**0.045**	<.0001	**0.047**	<.0001
Dual Eligible, after adjusting for frailty index	1.02	0.99	**0.039**	<.0001	**0.039**	<.0001
Dual Eligible, after adjusting for frailty indicators	1.03	0.99	**0.040**	<.0001	**0.041**	<.0001

6. Mortality

These tables show the odds of death for socially at-risk patients with AMI, HF and PN compared to other patients, and for hospitals who disproportionately serve socially at-risk patients compared to other hospitals, separately and in the same regression model. An odds ratio greater than 1 indicates socially at-risk patients have a higher risk of death compared to other patients. Each of the social and related risk factors are examined.

Table 6.1. AMI: Odds of Mortality due to Patient or Hospital Social Risk

Social & Related Risk Factor		AMI: Mortality	
		Patient or Hospital Risk in Separate Models	
		OR	P-Value
Dual	Dual Patient	**0.97**	0.01
	High-Dual hospital	1.03	0.13
Disabled	Disabled Patient	**1.20**	0.00
	High-disabled hospital	**1.08**	0.00
Black	Black Patient	**0.87**	0.00
	High-Black hospital	1.02	0.32
Hispanic	Hispanic Patient	**0.57**	0.00
	High-Hispanic hospital	0.98	0.17
Rural	Rural Patient	**1.06**	0.00
	Rural Hospital	**1.09**	0.00
Low-income	Low-income Patient	**1.04**	0.01
	High-share of low-income	**0.93**	0.00
Complexity	Complex Patient	**1.12**	0.00
	High-share of medically complex	0.97	0.07

Social & Related Risk Factor		AMI Mortality	
		Patient Risk, adjusting for hospital risk, or Hospital Risk adjusting for patient social risk (in same model)	
		OR	P-value
Dual	Dual Patient, adjusting for hospital	**0.96**	0.00
	High-Dual hospital, adjusting for patient	**1.04**	0.05
Disabled	Disabled Patient, adjusting for hospital	**1.20**	0.00
	High-disabled hospital, adjusting for patient	**1.07**	0.00
Black	Black Patient, adjusting for hospital	**0.85**	0.00
	High-Black hospital, adjusting for patient	**1.06**	0.00
Hispanic	Hispanic Patient, adjusting for hospital	**0.56**	0.00
	High-Hispanic hospital, adjusting for patient	**1.07**	0.00
Rural	Rural Patient, adjusting for hospital	**1.04**	0.02
	Rural Hospital, adjusting for patient	**1.06**	0.00
Low-income	Low-income Patient, adjusting for hospital	1.02	0.18
	High-share of low-income, adjusting for patient	**1.08**	0.00
Complexity	Complex Patient, adjusting for hospital	**1.12**	0.00
	High-share of medically complex, adjusting for patient	**0.96**	0.02

Table 6.2. HF: Odds of Mortality due to Patient or Hospital Social Risk

Social & Related Risk Factor		HF Mortality	
		Patient or Hospital Risk in Separate Models	
		OR	P-value
Dual	Dual Patient	**0.87**	0.00
	High-Dual hospital	**0.86**	0.00
Disabled	Disabled Patient	**1.09**	0.00
	High-disabled hospital	0.99	0.41
Black	Black Patient	**0.67**	0.00
	High-Black hospital	**0.89**	0.00
Hispanic	Hispanic Patient	**0.56**	0.00
	High-Hispanic hospital	**0.89**	0.00
Rural	Rural Patient	**1.11**	0.00
	Rural Hospital	**1.11**	0.00
Low-income	Low-income Patient	**0.91**	0.00
	High-share of low-income	1.02	0.10
Complexity	Complex Patient	1.01	0.20
	High-share of medically complex	**0.85**	0.00

Social & Related Risk Factor		HF Mortality	
		Patient Risk, adjusting for hospital risk, or Hospital Risk adjusting for patient social risk (in same model)	
		OR	P-value
Dual	Dual Patient, adjusting for hospital	**0.88**	0.00
	High-Dual hospital, adjusting for patient	**0.90**	0.00
Disabled	Disabled Patient, adjusting for hospital	**1.09**	0.00
	High-disabled hospital, adjusting for patient	0.98	0.25
Black	Black Patient, adjusting for hospital	**0.67**	0.00
	High-Black hospital, adjusting for patient	0.99	0.62
Hispanic	Hispanic Patient, adjusting for hospital	**0.57**	0.00
	High-Hispanic hospital, adjusting for patient	**0.96**	0.01
Rural	Rural Patient, adjusting for hospital	**1.08**	0.00
	Rural Hospital, adjusting for patient	**1.04**	0.01
Low-income	Low-income Patient, adjusting for hospital	**0.90**	0.00
	High-share of low-income, adjusting for patient	1.02	0.24
Complexity	Complex Patient, adjusting for hospital	1.02	0.06

	High-share of medically complex, adjusting for patient	**0.85**	0.00

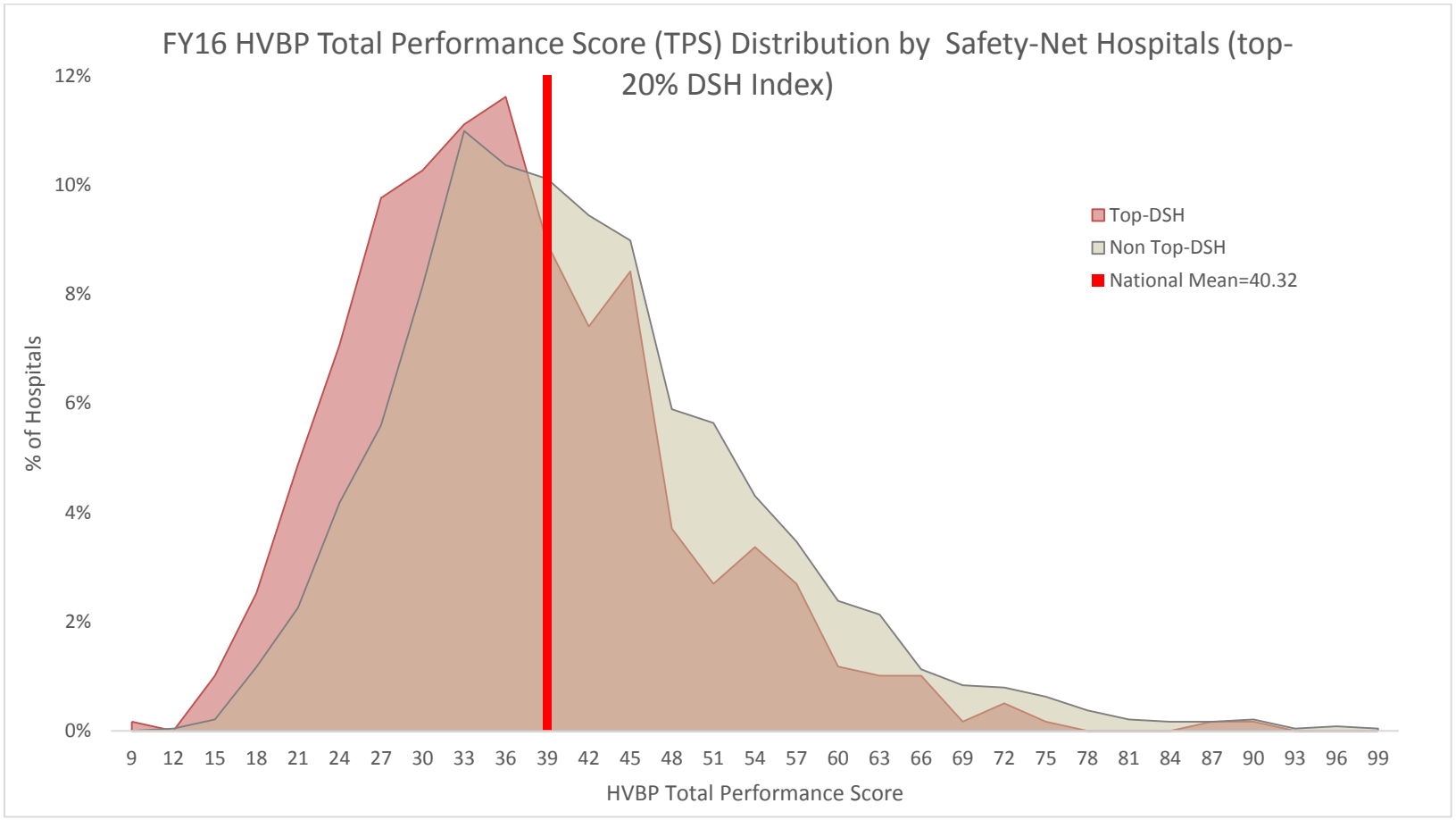
Table 6.3. PN: Odds of Mortality due to Patient or Hospital Social Risk

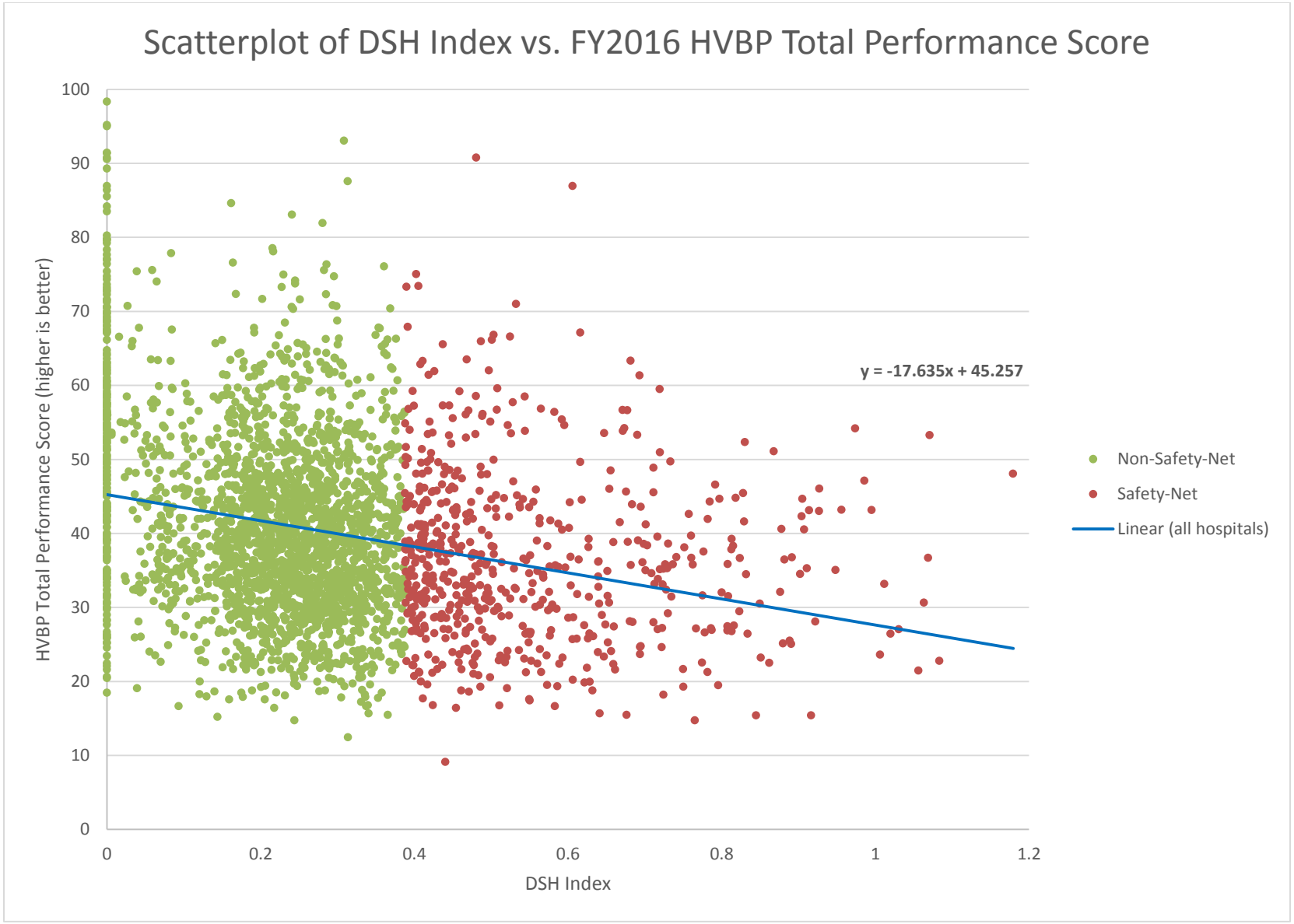
Social & Related Risk Factor		PN Mortality	
		Patient or Hospital Risk in Separate Models	
		OR	**P-Value**
Dual	Dual Patient	**0.95**	0.00
	High-Dual hospital	0.99	0.63
Disabled	Disabled Patient	**1.03**	0.03
	High-disabled hospital	**1.10**	0.00
Black	Black Patient	**0.86**	0.00
	High-Black hospital	**1.04**	0.02
Hispanic	Hispanic Patient	**0.56**	0.00
	High-Hispanic hospital	**0.94**	0.00
Rural	Rural Patient	**1.12**	0.00
	Rural Hospital	**1.12**	0.00
Low-income	Low-income Patient	1.01	0.51
	High-share of low-income	**0.94**	0.00
Complexity	Complex Patient	**0.93**	0.00
	High-share of medically complex	**0.90**	0.00

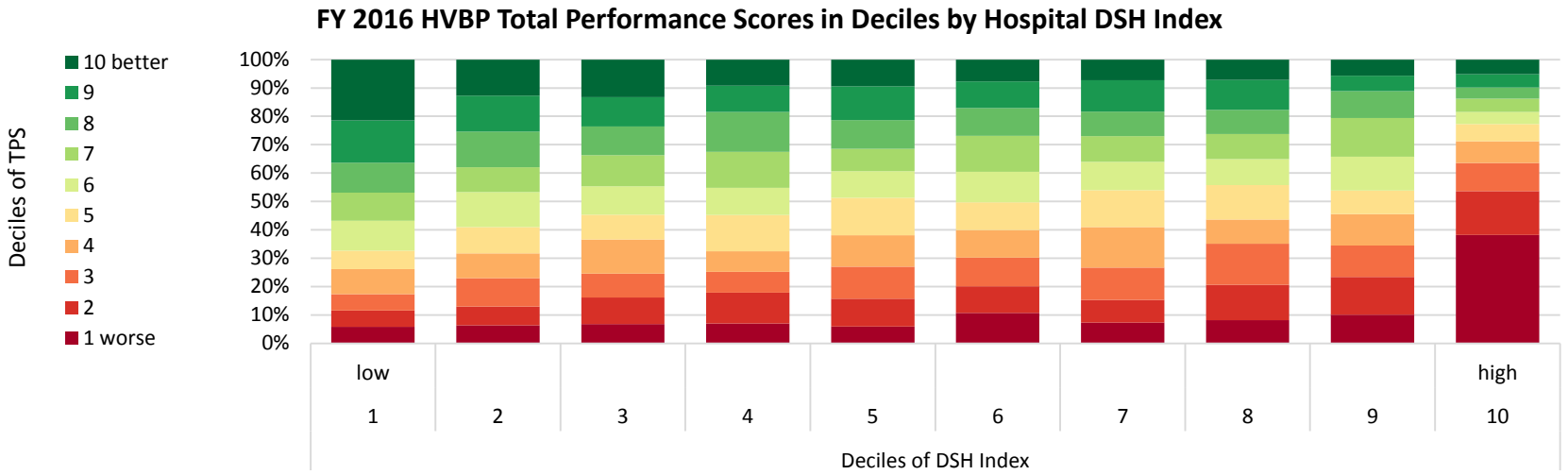
Social & Related Risk Factor		PN Mortality	
		Patient Risk, adjusting for hospital social risk, or Hospital Risk adjusting for patient social risk (in same model)	
		OR	**P-Value**
Dual	Dual Patient, adjusting for hospital	**0.95**	0.00
	High-Dual hospital, adjusting for patient	1.01	0.71
Disabled	Disabled Patient, adjusting for hospital	1.02	0.05
	High-disabled hospital, adjusting for patient	**1.10**	0.00
Black	Black Patient, adjusting for hospital	**0.84**	0.00
	High-Black hospital, adjusting for patient	**1.08**	0.00
Hispanic	Hispanic Patient, adjusting for hospital	**0.55**	0.00
	High-Hispanic hospital, adjusting for patient	**1.03**	0.04
Rural	Rural Patient, adjusting for hospital	**1.09**	0.00
	Rural Hospital, adjusting for patient	**1.05**	0.01
Low-income	Low-income Patient, adjusting for	0.99	0.42

	hospital		
	High-share of low-income, adjusting for patient	**1.08**	0.00
Complexity	Complex Patient, adjusting for hospital	**0.93**	0.00
	High-share of medically complex, adjusting for patient	**0.90**	0.00

7. Program Impacts




Scatterplot of DSH Index vs. FY2016 HVBP Total Performance Score
HVBP Total Performance Score (higher is better)
DSH Index
y = -17.635x + 45.257
Non-Safety-Net
Safety-Net
Linear (all hospitals)
0
10
20
30
40
50
60
70
80
90
100
0
0.2
0.4
0.6
0.8
1
1.2



		Average TPS	% of each TPS decile									
			1 worse	2	3	4	5	6	7	8	9	10 better
Deciles of DSH Index (1 is low, 10 is high)	1	52.40	5.8%	5.8%	5.8%	8.8%	6.5%	10.5%	9.9%	10.5%	15.0%	21.4%
	2	41.71	6.3%	6.7%	10.0%	8.7%	9.3%	12.3%	8.7%	12.7%	12.7%	12.7%
	3	40.92	6.8%	9.4%	8.4%	12.0%	8.7%	10.0%	11.0%	10.0%	10.4%	13.3%
	4	40.01	7.0%	10.8%	7.3%	7.3%	12.7%	9.6%	12.7%	14.0%	9.2%	9.2%
	5	40.62	6.0%	9.7%	11.3%	11.0%	13.2%	9.4%	7.9%	10.1%	11.9%	9.4%
	6	39.32	10.7%	9.4%	10.1%	9.7%	9.7%	10.7%	12.8%	9.7%	9.4%	7.7%
	7	39.18	7.3%	8.0%	11.3%	14.3%	13.0%	10.0%	9.0%	8.7%	11.0%	7.3%
	8	38.44	8.2%	12.5%	14.4%	8.5%	12.1%	9.2%	8.9%	8.5%	10.5%	7.2%
	9	37.83	10.1%	13.3%	11.1%	11.1%	8.2%	12.0%	13.6%	9.5%	5.4%	5.7%
	10	35.40	38.2%	15.5%	9.9%	7.7%	6.0%	4.3%	4.7%	3.9%	4.7%	5.2%

8. Policy Options

- Summary of policy option combinations examined in FY 2015 – risk-adjusting MSPB by duals and remove patient safety

FY2015 MSPB Policy Simulation Options – Changes in Measure Scores after Risk-adjusting for Duals and/or Medical Complexity

HVBP Policy Simulation Option			After SES risk-adjustment- Mean Measure Rates				
No.		*Efficiency Domain (MSPB)*	*All*	*Safety-Net*	*Rest*	*Difference*	*p-value*
2	**MSPB**	*Current (2015) Program*	0.987	0.995	0.984	0.011	**0.003**
2a		**Dual**	0.986	0.988	0.985	0.003	0.456
2b		**Complexity**	0.987	0.996	0.985	0.011	**0.002**
2c		**Dual + Complexity**	0.986	0.989	0.985	0.003	0.344

HVBP Policy Simulation Option			After SES risk-adjustment- Mean Measure Final Score				
No.		*Efficiency Domain (MSPB)*	*All*	*Safety-Net*	*Rest*	*Difference*	*p-value*
2	**MSPB**	*Current (2015) Program*	2.06	1.96	2.08	-0.12	0.29
2a		**Dual**	2.04	2.07	2.03	0.04	0.75
2b		**Complexity**	2.06	1.95	2.08	-0.13	0.25
2c		**Dual + Complexity**	2.06	2.08	2.05	0.03	0.80

HVBP Policy Simulation Option			After SES risk-adjustment- Mean Measure Achievement Score				
No.		*Efficiency Domain (MSPB)*	*All*	*Safety-Net*	*Rest*	*Difference*	*p-value*
2	**MSPB**	*Current (2015) program*	1.87	1.76	1.90	-0.14	0.25
2a		**Dual**	1.86	**1.91**	1.85	0.05	0.65
2b		**Complexity**	1.87	1.76	1.90	-0.14	0.24
2c		**Dual + Complexity**	1.87	**1.91**	1.86	0.05	0.66

HVBP Policy Simulation Option			After SES risk-adjustment- Mean Measure Improvement Score				
No.		*Efficiency Domain (MSPB)*	*All*	*Safety-Net*	*Rest*	*Difference*	*p-value*
2	**MSPB**	*Current (2015) Program*	0.92	0.88	0.93	-0.05	0.54
2a		**Dual**	0.90	0.90	0.90	**0.00**	0.999
2b		**Complexity**	0.91	0.87	0.92	-0.05	0.56
2c		**Dual + Complexity**	0.91	0.90	0.91	-0.02	0.82

FY2016 MSPB Policy Simulation Options– Changes in Efficiency Domain Scores After Risk-adjusting MSPB Measure by Duals and/or Medical Complexity, either using HCCs from the measure's risk-adjustment with a 90-day look back, or using HCCs from the RAPS Medicare claims with one-year look back

No.	HVBP Policy Simulation	FY 2016- Average Domain Scores (weighted)				
		All	*Safety-Net*	*Rest*	*Difference*	*p-value*
0	**Efficiency Domain: Original risk-adjustment**	5.40	4.80	5.55	**-0.75**	0.03
2a	**Efficiency Domain: Risk-adjust MSPB by duals**	5.37	5.14	5.42	-0.28	0.42
2b	**Efficiency Domain: Risk-adjust MSPB by medical complexity**	5.41	4.80	5.56	**-0.77**	**0.03**
2c	**Efficiency Domain: Risk-adjust MSPB by duals and medical complexity**	5.37	5.14	5.42	-0.29	0.41
2b(ii)	**Efficiency Domain: Risk-adjust MSPB by medical complexity (RAPS)**	5.40	4.78	5.55	**-0.77**	**0.03**
2c(ii)	**Efficiency Domain: Risk-adjust MSPB by duals and medical complexity (RAPS)**	5.36	5.14	5.41	-0.27	0.43

FY 2016- Overall R-squared for MSPB first-level regressions

Risk-Adjustment Option*	Overall R-Squared	
	Baseline	**Performance**
Original (no additions)	0.4508	0.4517
Dual	0.4515	0.4523
RAPS Risk Quintile	0.4513	0.4523
Dual + RAPS Risk Quintile	0.4519	0.4528

FY2015 Policy Simulation Option: Remove Patient Safety Measures from Outcomes Domain

- FY2015 HVBP Program Year, based on scores calculated from Medicare claims

Domain and Weight		Mean Weighted Domain Score					Revised Weighted Score after removing PS measures				
		All	*Safety-Net*	*Rest*	*Diff*	*p-value*	*All*	*Safety-Net*	*Rest*	*Diff*	*p-value*
Patient Experience	**30%**	13.4	10.3	14.2	**-3.9**	<.0001	13.5	10.5	14.2	**-3.8**	<.0001
Outcomes	**30%**	12.7	12.6	12.8	-0.2	0.5	9.1	9.4	9.0	0.3	0.3

Efficiency	**20%**	4.5	4.3	4.5	-0.2	0.4	4.5	4.4	4.5	-0.1	0.6
Process of Care	**20%**	11.5	10.8	11.7	**-0.9**	<.0001	11.6	10.9	11.7	**-0.8**	0.0002
Total Performance Score	**100%**	40.6	36.6	41.6	**-5.0**	<.0001	37.3	33.6	38.2	**-4.6**	<.0001

- FY2015 HVBP Program Year, based on reported scores

Domain and Weight		**Mean Weighted Domain Score**					**Revised Weighted Score after removing PS measures**				
		All	*Safety-Net*	*Rest*	*Diff*	*p-value*	*All*	*Safety-Net*	*Rest*	*Diff*	*p-value*
Patient Experience	**30%**	13.6	10.4	14.4	**-4.0**	<0.001	13.8	10.7	14.5	**-3.8**	<.0001
Outcomes	**30%**	13.7	13.6	13.8	-0.2	0.5	10.4	10.6	10.3	0.3	0.4
Efficiency	**20%**	4.6	4.4	4.6	-0.2	0.4	4.7	4.5	4.7	-0.2	0.6
Process of Care	**20%**	11.7	10.9	11.9	**-0.9**	<0.001	11.8	11.3	12.0	**-0.7**	0.0020
Total Performance Score	**100%**	41.6	37.5	42.6	**-5.1**	<0.001	38.6	34.7	39.6	**-4.9**	<.0001

Appendix Chapter 8: Medicare Advantage

Medicare Advantage Detailed Methodology

These analyses used beneficiary and contract-level data for measures included in the Medicare Advantage Star Rating Program to assess the relationship between measures of social risk (a set of measures more comprehensive than SES) and contract performance. Data for program measurement year 2014 (used for the 2016 Star Ratings and 2017 Quality Bonus Payments) were used. Analyses included all MA and MA-PD contracts eligible for Star Ratings. Contracts that have terminated, are too new for Star Ratings or did not have adequate enrollees to be scored for at least one measure were excluded. Contracts operating exclusively in Puerto Rico (which has different criteria for dual eligibility and no low income subsidy program) were excluded.

In 2016, there were 45 distinct Part D (prescription drug) and Part C (non-prescription-drug) measures used to rate MA-PD contracts (Table 1).

Appendix Table 8.1a. Measures included in the Medicare Advantage Star Rating program for 2016

Measure Name (*Domains listed in italics)*	**Data Source**	**Level at Which Data is Available**	**Notes on measures: whether or not already adjusted, whether apply broadly, etc.**
Domain: Staying Healthy: Screenings, Tests, Vaccines			
Breast Cancer Screening	HEDIS	Patient-level data	
Colorectal Cancer Screening	HEDIS	Patient-level data	
Annual Flu Vaccine	CAHPS	Patient-level data	
Improving or Maintaining Physical Health	HOS	Patient-level data	Adjusted for age, gender, race, education, chronic conditions, and income
Improving or Maintaining Mental Health	HOS	Patient-level data	Adjusted for age, gender, race, education, chronic conditions, and income
Monitoring Physical Activity	HEDIS/HOS	Patient-level data	
Adult BMI Assessment	HEDIS	Patient-level data	
Domain: Managing Chronic (Long Term) Conditions			
Special Needs Plan (SNP) Care Management	Plan Reporting	Contract-level data only	Only used for SNPs
Care for Older Adults – Medication Review	HEDIS	Contract-level data only	Only used for SNPs
Care for Older Adults – Functional Status Assessment	HEDIS	Contract-level data only	Only used for SNPs
Care for Older Adults – Pain Assessment	HEDIS	Contract-level data only	Only used for SNPs
Measure Name (*Domains listed in italics)*	**Data Source**	**Level at Which Data is Available**	**Notes on measures: whether or not already adjusted, whether**

			apply broadly, etc.
Osteoporosis Management in Women who had a Fracture	HEDIS	Patient-level data	
Diabetes Care – Eye Exam	HEDIS	Patient-level data	
Diabetes Care – Kidney Disease Monitoring	HEDIS	Patient-level data	
Diabetes Care – Blood Sugar Controlled*	HEDIS	Patient-level data	
Controlling Blood Pressure	HEDIS	Patient-level data	
Rheumatoid Arthritis Management	HEDIS	Patient-level data	
Improving Bladder Control	HEDIS/HOS	Patient-level data	Specification change for 2016
Reducing the Risk of Falling	HEDIS/HOS	Patient-level data	
Plan All-Cause Readmissions*	HEDIS	Patient-level data	Reverse coded for analyses; Adjusted for age, comorbidity and reason for initial hospitalization
Domain: Member Experience with Health Plan			
Getting Needed Care	CAHPS	Patient-level data (analyses performed at contract level)	Adjusted for age, education, general health, mental health, proxy, DE, LIS
Getting Appointments and Care Quickly	CAHPS	Patient-level data (analyses performed at contract level)	Adjusted for age, education, general health, mental health, proxy, DE, LIS
Customer Service	CAHPS	Patient-level data (analyses performed at contract level)	Adjusted for age, education, general health, mental health, proxy, DE, LIS
Overall Rating of Health Care Quality	CAHPS	Patient-level data (analyses performed at contract level)	Adjusted for age, education, general health, mental health, proxy, DE, LIS
Overall Rating of Plan	CAHPS	Patient-level data (analyses performed at contract level)	Adjusted for age, education, general health, mental health, proxy, DE, LIS
Care Coordination	CAHPS	Patient-level data (analyses performed at contract level)	Adjusted for age, education, general health, mental health, proxy, DE, LIS
Domain: Member Complaints and Changes in the Health Plan's Performance			
Complaints about the Health Plan	Complaint Tracking Module	Contract-level data	
Members Choosing to Leave the Plan	Medicare Beneficiary Database Suite of Systems	Contract-level data	
Measure Name (*Domains listed in italics)*	**Data Source**	**Level at Which Data is Available**	**Notes on measures: whether or not already adjusted, whether apply broadly, etc.**
Beneficiary Access and Performance Problems	CMS Administrative Data	Contract-level data	

Health Plan Quality Improvement	Based on changes in performance in other measures from previous year	Contract-level data	Not included in these analyses
Domain: Health Plan Customer Service			
Plan Makes Timely Decisions about Appeals	Independent Review Entity	Contract-level data	
Reviewing Appeals Decisions	Independent Review Entity	Contract-level data	
Call Center – Foreign Language and TTY Availability	Call Center	Contract-level data	
Domain: Drug Plan Customer Service			
Call Center – Foreign Language and TTY Availability	Call Center	Contract-level data	
Appeals Auto–Forward	Independent Review Entity	Contract-level data	
Appeals Upheld	Independent Review Entity	Contract-level data	
Domain: Member Complaints and Changes in the Drug Plan's Performance			
Complaints about the Drug Plan	Complaint Tracking Module	Contract-level data	
Members Choosing to Leave the Plan	Medicare Beneficiary Database Suite of Systems	Contract-level data	
Members Choosing to Leave the Plan	Medicare Beneficiary Database Suite of Systems	Contract-level data	
Drug Plan Quality Improvement	Based on changes in performance in other measures from previous year	Contract-level data	Not included in these analyses
Domain: Member Experience with the Drug Plan			
Rating of Drug Plan	CAHPS	Patient-level data (analyses performed at contract level)	Adjusted for age, education, general health, mental health, proxy, DE, LIS
Getting Needed Prescription Drugs	CAHPS	Patient-level data (analyses performed at contract level)	Adjusted for age, education, general health, mental health, proxy, DE, LIS
Measure Name (*Domains listed in italics)*	**Data Source**	**Level at Which Data is Available**	**Notes on measures: whether or not already adjusted, whether apply broadly, etc.**
Domain: Drug Safety and Accuracy of Drug Pricing			
Medicare Plan Finder Price Accuracy	PDE data, MPF Pricing Files, HPMS approved formulary extracts, and data from First	Contract-level data	

	DataBank and Medi-span		
High Risk Medication*	Prescription Drug Event	Patient-level data	
Diabetes Treatment	Prescription Drug Event	Patient-level data	Specification change for 2016
Medication Adherence for Diabetes Medications	Prescription Drug Event; Medicare Enrollment Database; Common Working File	Patient-level data	
Medication Adherence for Hypertension	Prescription Drug Event; Medicare Enrollment Database; Common Working File	Patient-level data	
Medication Adherence for Cholesterol	Prescription Drug Event; Medicare Enrollment Database; Common Working File	Patient-level data	
Medication Therapy Management Program Completion Rate for Comprehensive Medication Review	Part D Plan Reporting	Contract-level data	

* These measures were reverse coded in the analyses so odds ratios below one are always interpreted as receiving worse care.

Measures of Social Risk

Multiple measures of social risk were examined for their association with performance on the quality measures and impact on the Star Ratings (Table 2). Each measure of social risk was constructed as a dichotomous variable, with "1" meaning the beneficiary had that social risk measure (e.g., resided in a rural area) and "0" indicating the beneficiary did not experience that measure of social risk. Measures derived from the census data were coded a "1" if the beneficiary resided in a ZCTA that was in the most at risk quintile of ZCTAs for the social risk factor being measured (e.g., the ZCTA was in the lowest quintile for median income). Related risk factors (such as disability) were also examined.

Appendix Table 8.1b. Measures of Social and Related Risk

Social or Related Risk Category	Beneficiary-level variable
Poverty (dual eligibility / low-income subsidy)	Dual-eligible status (full or partial at any point in the calendar year) / Low-income subsidy status (from Medicare enrollment file)
Poverty (ZCTA-level income)	ZCTA-level income (from census data)
Race/ethnicity: black versus non-black	Race/ethnicity (from Medicare enrollment file; if missing, imputed at census-block group level if possible)
Race/ethnicity: Hispanic versus non-Hispanic	Race/ethnicity (from Medicare enrollment file; if missing, imputed at census-block group level if possible)
Rurality	Home zip outside MSA
Disability	Original reason for Medicare entitlement (from Medicare enrollment file)

In the beneficiary-level analyses described below, models with (1) each social risk measure listed in Table 2 as the only social risk predictor, (2) both dual eligibility and disabled status as the only social risk predictors, and (3) all six social risk measures listed in Table 2 simultaneously were considered. Case-mix adjustment was also included in the models as appropriate for individual measures. In a second set of beneficiary-level analyses, the social risk predictor(s) of interest is the contract characteristic, applied at the beneficiary level. A third set of regressions will be conducted at the beneficiary level that includes both beneficiary-level predictors as well as analogous contract characteristics applied at the beneficiary-level (e.g. dual/LIS status with indicator for highest quintile of dual/LIS). A subset of measures is only available at the contract level (See table 1); for these measures analyses were only performed with the social risk predictors as a contract characteristic.

Association between Beneficiary-Level Social Risk and Performance

RAND performed a set of regression analyses using beneficiary-level data with social risk (SR in models below) factors as the main predictors of interest, and performance on the measures in the Star Rating Program as the main outcomes.

Model 1: GEE model was fit for each measure, assuming an independent working correlation matrix and obtaining empirical (robust) standard error estimates (Liang & Zeger, 1986). Let y_{ij} be performance for beneficiary i in contract j, which is assumed to be dichotomous (and is so all of the performance measures are examined at the beneficiary-level). The marginal mean performance, $\mu_{ij}=E(y_{ij})$, is modeled as

$$\eta_{ij} = h(\mu_{ij}) = \beta_0 + \beta_1 * SR_{ij}, \qquad \text{(Model 1)}$$

where h() represents the logit link function to be used for modeling the beneficiary-level dichotomous outcomes, providing a way to link the dichotomous outcome to the right-hand side predictors. Using standard notation, $h(\mu_{ij})$ is referred to as the linear predictor, η_{ij}, from here onward. (SR_{ij} is the social risk for beneficiary i in contract j. The coefficient on the beneficiary-level SR term, β_1, characterizes the total difference in performance for high social risk versus other beneficiaries in the population, reflecting both within-contract and between-contract differences in performance.

Model 2: The second set of analyses focused on estimating the average within-contract social risk disparity using contract random effects. This modeling approach is consistent with the analyses ASPE is performing to assess the association of social risk with performance measures in other Medicare programs (including the Hospital Value-Based Purchasing Program, Hospital Readmission Reduction Program, Hospital Acquired Condition Reduction Program, Medicare Shared Savings Program, Physician Value-Based Payment Modifier System). Specifically, Model 2, a random effects model with a random intercept term for contract and beneficiary-level social risk, is fit as:

$$\eta_{ij} = \beta_{0i} + \gamma_{10} SR_{ij}. \qquad \text{(Model 2)}$$

The intercept term, β_{0i} would be allowed to randomly vary contract-to-contract by modeling $\beta_{0i} = \gamma_{00} + \nu_{0i}$, where γ_{00} is an intercept term and ν_{0i} is a random effect that varies across contracts.

Sensitivity Analyses for Models with Beneficiary-Level Social Risk Measures

Sensitivity analyses (Model 3 and Model 4) were performed with a subset of the measures that included the HEDIS measures. These analyses focused on the DE/LIS indicator. Sensitivity analyses with the other social risk measures were not performed.

Model 3: Because random-effects models assume the contract-specific effects are uncorrelated with the measures of social risk (which may or may not be the case), the third set of analyses focused on estimating the average within-contract social risk disparity using contract fixed effects. This analysis is motivated by RAND's analyses for CMS related to assessing the potential effects of adjusting Medicare Advantage (MA) Star Ratings for beneficiary social risk. The model is a generalized linear model (GLM) with contract fixed effects, with contract entering the model as N-1 dummy variables for the N contracts in the analysis.

The between-contract differences include contract-level mean social risk as well as other non-measured characteristics that do not vary within contract. This approach aligns with the current case-mix adjustment practice used in the MA Star Ratings; CAHPS measures that are included in the MA Star Ratings are risk-adjusted for beneficiary characteristics using Model 2 (Zaslavsky, Zaborski, Ding, et al., 2001).

The linear predictor of the Model 3 GLM would be:

$$\eta_{ij} = \beta_0 + \beta_1 * SES_{ij} + \gamma_i, \qquad \text{(Model 3)}$$

where γ_i is the fixed effect for contract *i*. β_1 can be interpreted as the average within-contract effect of beneficiary social risk on performance (Localio, Berlin, Ten Have, and Kimmel, 2001; Zaslavsky, Zaborski, Ding, et al., 2001).

Model 4: In order for the random effects models to truly estimate within-contract difference of social risk, the model must group-mean center the beneficiary-level social risk -- in other words, the contract mean social risk measure must be subtracted from the beneficiary-level social risk measure prior to analysis -- in order to interpret γ_{10} as a within-contract effect (Raudenbush and Bryk, 2002). Therefore, Model 4 is:

$$\eta_{ij} = \beta_{0i} + \gamma_{10}(SR_{ij} - SR_{*i}) \qquad \text{(Model 4)}$$

Examining Consistency of Beneficiary-Level Social Risk Effect

Analyses examining the consistency of the beneficiary-level (within-contract) social risk effect were conducted. A random slope for the social risk term of interest was added to the models (essentially adding an interaction between the beneficiary social risk factor and the contract random effect). The model built upon Model 2 by modeling both contract intercepts and slopes as random by adding a random slope term, ν_{1i}:

$$\eta_{ij} = \beta_{0i} + \beta_{1i} SR_{ij} \qquad \text{(Model 5)}$$

$$\beta_{0i} = \gamma_{00} + \nu_{0i},$$

$$\beta_{1i} = \gamma_{10} + \nu_{1i},$$

The analyses examined whether the social risk effect significantly varied across contracts and summarize best linear unbiased predictions (BLUPs) of the contract-specific beneficiary-level social risk difference for those of high social risk (SR_{ij}=1) versus high SR (SR_{ij}=0) to examine the range of social risk disparities across contracts.

Association between Contract-Level Social Risk and Performance

Another set of analyses were conducted at the beneficiary level in which the predictor of interest is the contract characteristic, applied at the beneficiary level. Predictors are listed in Table 8.1c below.

Appendix Table 8.1c. Contract-Level Measures of Social and Related Risk

Social and Related Risk Category	Contract-level variable (applied to beneficiary)
Poverty (dual eligibility / low-income subsidy)	Highest quintile of dual/LIS beneficiaries
Poverty (full, partial, non-dual)	Highest quintile of full dual beneficiaries
Poverty (zip-level income)	Lowest quintile of zip-level income
Race/ethnicity: black versus non-black	Highest quintile of proportion black
Race/ethnicity: Hispanic versus non-Hispanic	Highest quintile of proportion Hispanic
Rurality	Highest quintile of rural beneficiaries
Disability	Highest quintile of disabled beneficiaries

Again, these factors were considered individually. An additional set of regressions will be conducted at the beneficiary level that includes both beneficiary-level predictors as well as analogous contract characteristics applied at the beneficiary- level (e.g., dual/LIS status with indicator for highest quintile of dual/LIS). These analyses help inform whether it is the beneficiary characteristics per se or perhaps the contract having a high proportion of high social risk beneficiaries and potentially being under-resourced to meet the needs of its enrollees that is associated with lower performance.

Analyses with Contract-Level Measures

Some of the measures included in the Star Rating program are only available at the contract level. Other measures, such as CAHPS measures, have been thoroughly examined previously and are already adjusted for measures of social risk. For these measures, the association between contract-level measures of social risk and performance at the contract level was examined. Most of these measures are scored on a 0-100 scale. The coefficient for the measures of social risk represents the total difference in performance for high-social risk contracts (as measured by being in the highest quintile for the percentage of high-social risk beneficiaries) versus other contracts with fewer high-social risk beneficiaries. As with the beneficiary-level models, models with (1) each contract-level measure of social risk as the only social risk (2) both dual eligibility and disabled status as the only social risk predictors, and (3) all six social risk measures simultaneously were considered.

Appendix Table 8.2: Performance on HEDIS Measures in 2013 for full versus partial duals

Measure	All	Full Dual	Partial Dual	Not Dual
C01: Colorectal Screening	73.4%	60.3%	58.2%	75.7%
C02: Cardiovascular Care - Cholesterol Screening	90.8%	87.2%	86.8%	91.7%
C03: Diabetes Care - Cholesterol Screening	88.9%	85.0%	85.5%	90.3%
C08: Adult BMI Assessment	90.5%	86.4%	85.6%	91.5%
C13: Osteoporosis Management in Women who had a Fracture	27.8%	21.8%	23.3%	29.1%
C14: Diabetes Care - Eye Exam	66.2%	65.0%	56.1%	68.3%
C15: Diabetes Care - Kidney Disease Monitoring	91.5%	90.1%	90.6%	91.9%
C16: Diabetes Care - Blood Sugar Controlled	78.5%	70.0%	69.0%	81.3%
C17: Diabetes Care - Cholesterol Controlled	53.9%	47.2%	47.8%	56.3%
C18: Controlling Blood Pressure	61.9%	60.2%	59.1%	62.7%
C19: Rheumatoid Arthritis Management	76.2%	70.2%	73.5%	77.2%

Note: full-dual beneficiaries are those who are considered fully dual in all months in 2013, partial-dual beneficiaries are defined as any other dual in any month in 2013.

Appendix Table 8.3: Social Risk and MA Patient-Level Measure Performance, Odds of Successfully Achieving Measure, Total Effects, 2014

Domain/Measure	Average Performance	Dual/LIS	Low-Income ZCTA	Black	Hispanic	Rural	Disabled
Staying Healthy: Screenings, Tests, Vaccines							
Breast Cancer Screening	76.4%	**0.65**	**0.82**	**1.18**	**1.47**	**0.74**	**0.72**
Colorectal Cancer Screening	71.7%	0.67	0.78	0.72	1.65	**0.56**	**0.63**
Annual Flu Vaccine	73.5%	**0.70**	**0.72**	**0.53**	**0.88**	**0.87**	**0.64**
Improving or Maintaining Physical Health	73.2%	**0.92**	0.99	1.00	0.98	1.01	**0.86**
Improving or Maintaining Mental Health	79.1%	**0.81**	**0.90**	**0.85**	1.01	**0.95**	0.95
Monitoring Physical Activity	50.8%	0.99	**0.92**	**1.19**	**1.33**	**0.75**	**1.17**
Adult BMI Assessment	97.0%	**0.56**	**0.47**	**0.73**	**1.43**	**0.33**	**0.61**
Managing Chronic (Long Term) Conditions							
Osteoporosis Management in Women who had a Fracture	39.9%	**0.77**	0.83	1.07	**1.61**	**0.51**	**0.64**
Diabetes– Eye Exam	76.7%	**0.69**	**0.64**	**0.83**	**1.35**	**0.56**	**0.53**
Diabetes– Kidney Disease Monitoring	94.1%	**0.72**	**0.75**	**1.11**	**1.78**	**0.49**	**0.57**
Diabetes– Blood Sugar Controlled (reverse-coded)	83.2%	**0.50**	**0.55**	**0.66**	0.97	**0.62**	**0.47**
Controlling Blood Pressure	70.4%	**0.75**	**0.75**	**0.56**	**0.88**	0.96	**0.72**
Rheumatoid Arthritis Management	78.8%	**0.78**	**0.80**	**0.86**	0.90	0.97	0.97
Improving Bladder Control	35.2%	**0.94**	**0.87**	**0.83**	**1.13**	**0.89**	**1.13**
Reducing the Risk of Falling	59.9%	**1.92**	**1.25**	**1.65**	**1.59**	**0.81**	**1.34**
Plan All-Cause Readmissions (reverse-coded)	86.9%	**0.89**	**0.95**	**0.94**	**1.07**	**0.97**	1.01
Drug Safety and Accuracy of Drug Pricing							
High-Risk Medication *(reverse coded)*	93.7%	**0.88**	1.04	**1.35**	**1.78**	**0.83**	**0.58**
Medication Adherence for Diabetes Medications	78.0%	**0.82**	**0.76**	**0.57**	**0.86**	1.00	**0.67**
Medication Adherence for Hypertension	80.3%	**0.72**	**0.73**	**0.56**	**0.82**	0.99	**0.62**
Medication Adherence for Cholesterol	76.4%	**0.76**	**0.71**	**0.53**	**0.69**	1.01	**0.69**

BMI=body mass index. Separate analyses were conducted for each group. Models control for between-contract differences. **All bolded/shaded comparisons significant at p<0.05**.

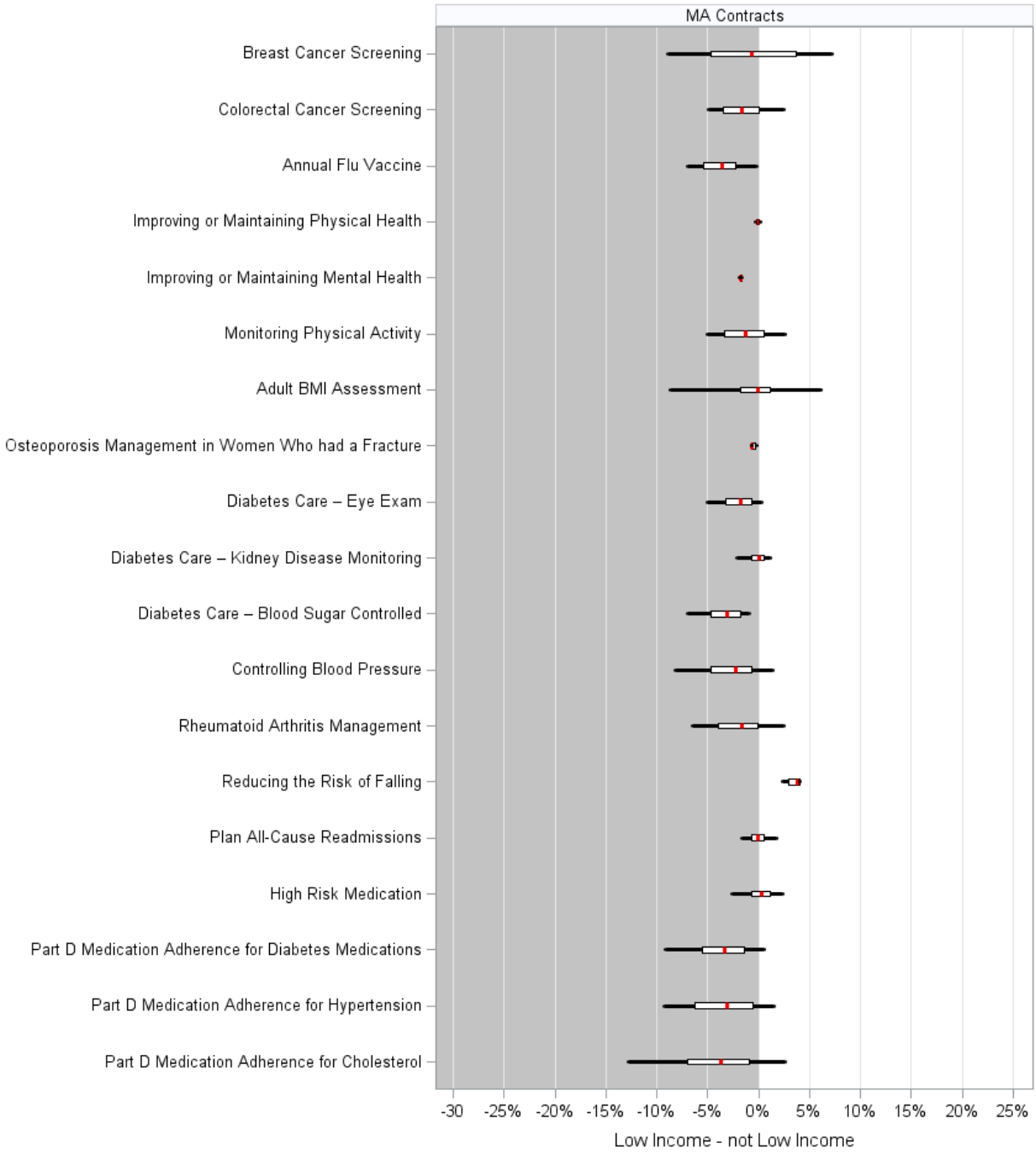
Appendix Table 8.4: Social Risk and MA Patient-Level Measure Performance, Odds of Successfully Achieving Measure, All Social Risk Factors In Model

Domain/Measure	Average Performance	Dual/LIS	Low-Income ZCTA	Black	Hispanic	Rural	Disabled
Staying Healthy: Screenings, Tests, Vaccines							
Breast Cancer Screening	76.4%	**0.70**	**0.95**	**1.51**	**1.65**	**0.74**	**0.90**
Colorectal Cancer Screening	71.7%	**0.83**	**0.93**	**1.22**	**1.35**	**0.56**	**0.87**
Annual Flu Vaccine	73.5%	**0.88**	**0.93**	**0.63**	1.01	**0.87**	**0.78**
Improving or Maintaining Physical Health	73.2%	**0.92**	0.99	1.04	1.00	1.01	**0.86**
Improving or Maintaining Mental Health	79.1%	**0.81**	**0.91**	**0.85**	1.03	**0.95**	0.96
Monitoring Physical Activity	50.8%	**0.94**	**0.91**	**1.30**	**1.38**	**0.75**	**1.21**
Adult BMI Assessment	97.0%	1.01	1.00	1.06	**1.51**	**0.33**	**0.89**
Managing Chronic (Long Term) Conditions							
Osteoporosis Management in Women who had a Fracture	39.9%	**0.79**	1.02	**0.90**	**1.13**	**0.51**	**0.71**
Diabetes– Eye Exam	76.7%	**0.89**	**0.95**	**1.10**	**1.28**	**0.56**	**0.66**
Diabetes– Kidney Disease Monitoring	94.1%	0.97	0.97	**1.43**	**1.37**	**0.49**	**0.71**
Diabetes– Blood Sugar Controlled (reverse-coded)	83.2%	**0.78**	**0.92**	**0.81**	**0.78**	**0.62**	**0.65**
Controlling Blood Pressure	70.4%	**0.95**	**0.96**	**0.66**	**0.92**	0.96	**0.86**
Rheumatoid Arthritis Management	78.8%	**0.89**	**0.91**	1.00	**1.11**	0.97	**1.09**
Improving Bladder Control	35.2%	**0.95**	**0.90**	**0.87**	**1.22**	**0.89**	**1.17**
Reducing the Risk of Falling	59.9%	**1.66**	**1.06**	**1.36**	**1.26**	**0.81**	**1.28**
Plan All-Cause Readmissions (reverse-coded)	86.9%	**0.90**	0.99	**1.04**	**1.13**	**0.97**	1.02
Drug Safety and Accuracy of Drug Pricing							
High-Risk Medication *(reverse coded)*	93.7%	**0.68**	1.00	**1.52**	**1.73**	**0.83**	**0.57**
Medication Adherence for Diabetes Medications	78.0%	**1.04**	**0.94**	**0.59**	**0.71**	1.00	**0.74**
Medication Adherence for Hypertension	80.3%	**0.95**	**0.93**	**0.63**	**0.75**	0.99	**0.72**
Medication Adherence for Cholesterol	76.4%	**1.02**	**0.93**	**0.56**	**0.60**	1.01	**0.78**

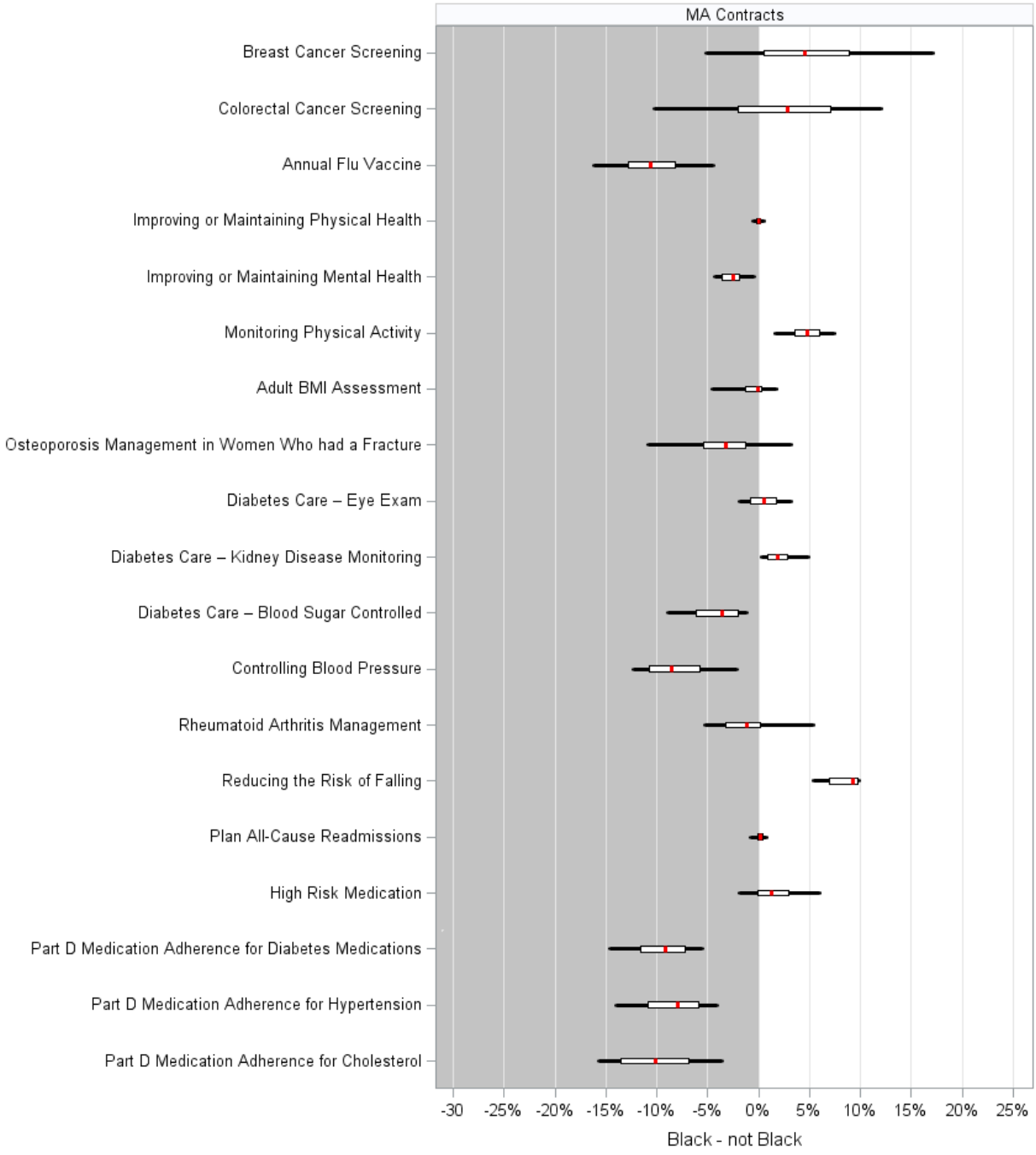
BMI=body mass index. Separate analyses were conducted for each group. Models control for between-contract differences. **All bolded/shaded comparisons significant at p<0.05**.

Appendix Figure 8.1: Variability of Effect of Social Risk Status

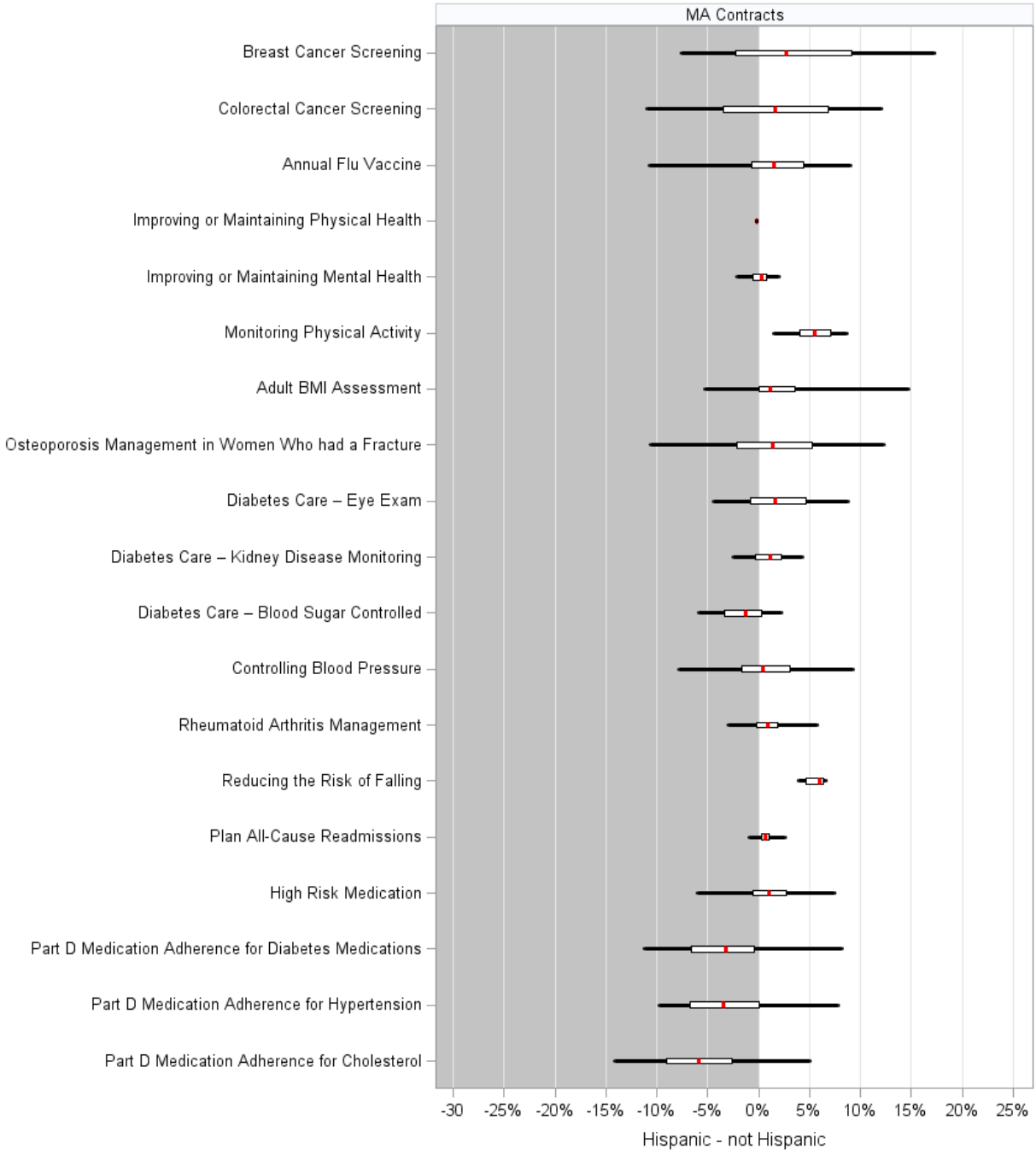
a. Variability of Effect of Low-Income ZCTA



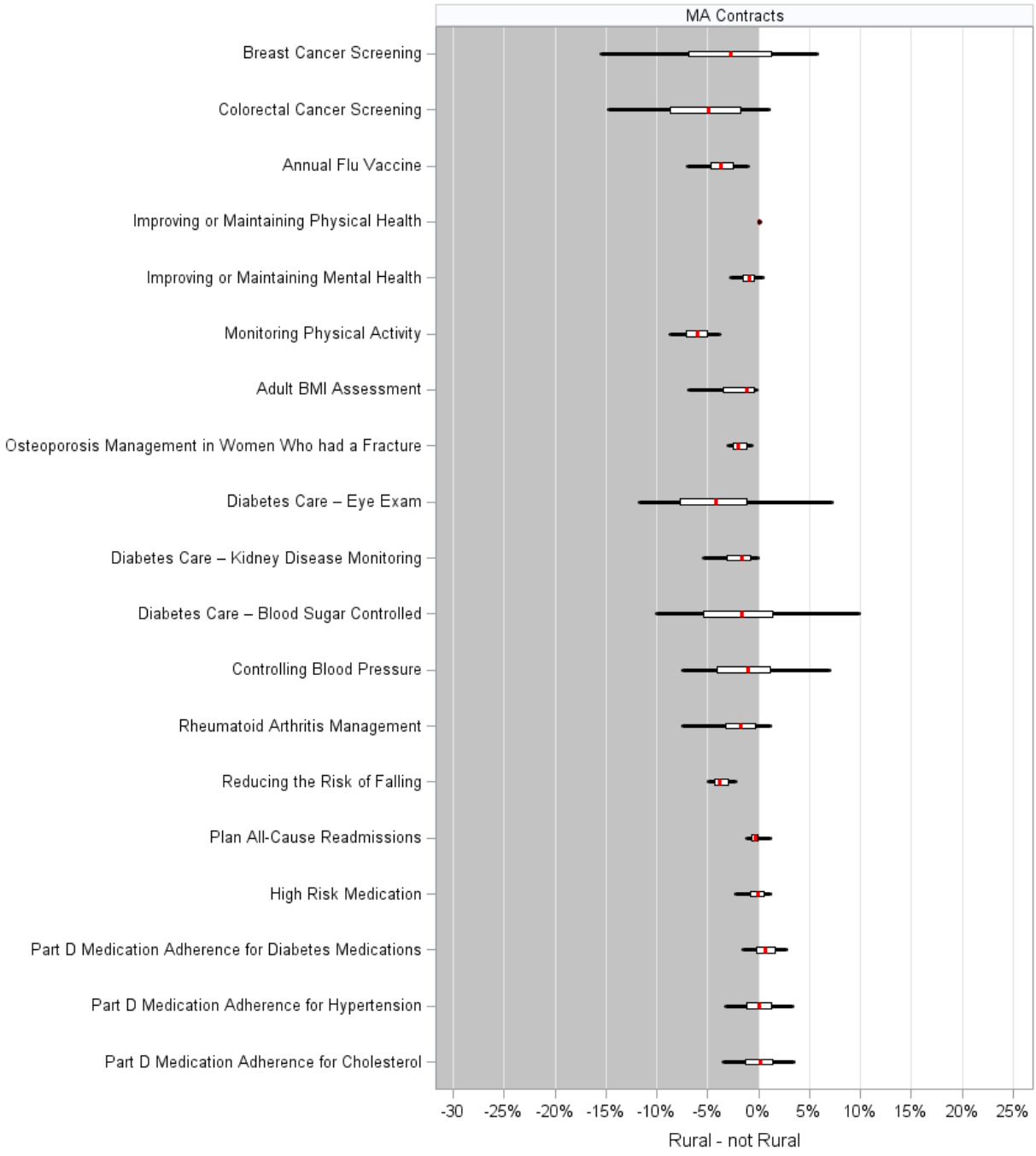
b. Variability of Effect of Black



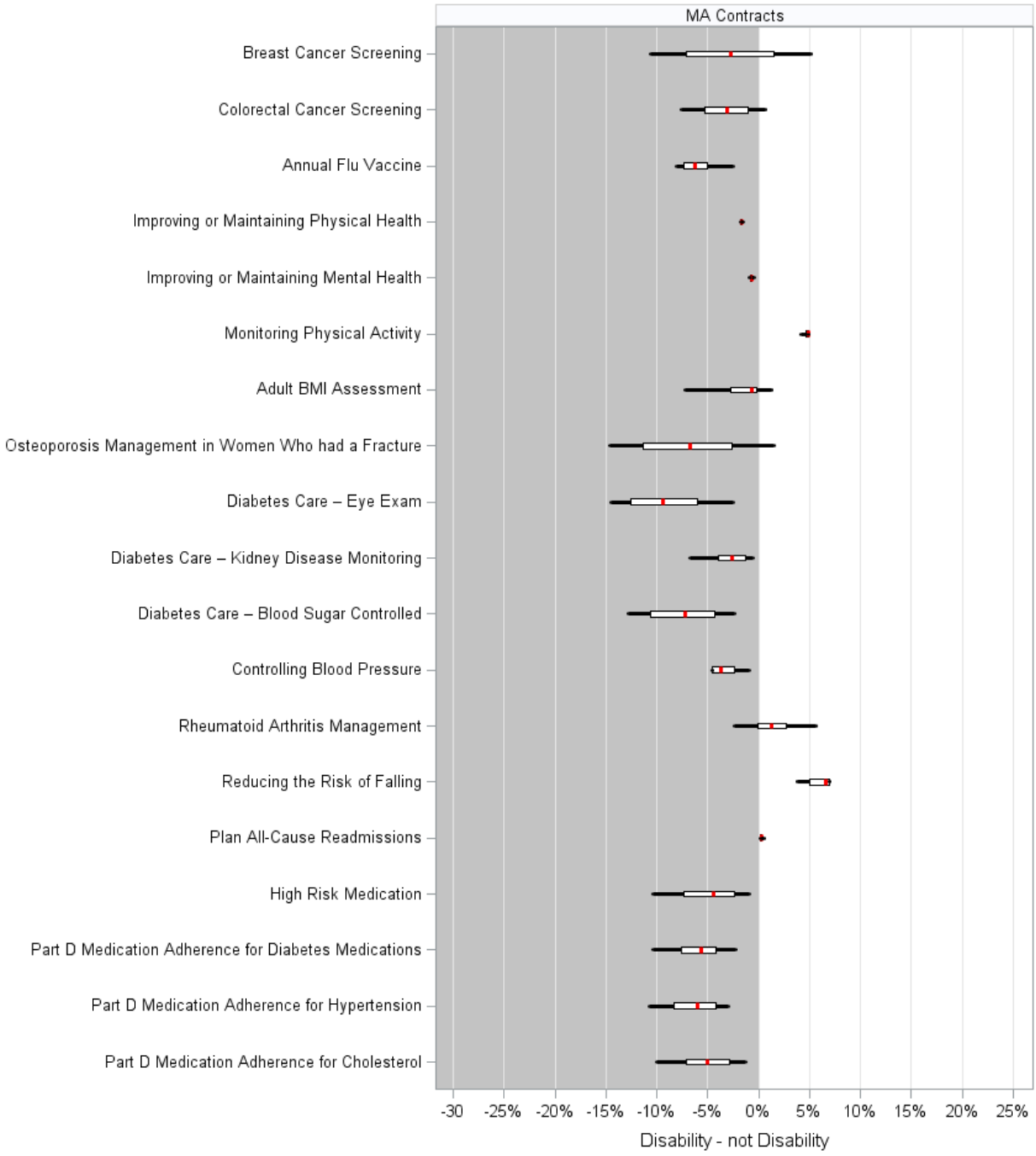
c. Variability of Effect of Hispanic



d. Variability of Effect of Rural



e. Variability of Effect of Disability



Appendix Table 8.5: Creation and Application of a Disparity Index

To create a disparity index, the first step is to run the entire star analysis first without social risk adjustment, and then after adjusting for the factor of interest (in this case, adjusting the 18 clinical measures for dual/LIS status at the measure level). For each contract, a delta between the unadjusted star rating and the adjusted star rating can then be calculated.

Contracts are then broken into groups by their proportion dual/LIS; for the example contained here, contracts were broken into four groups as shown in the table below. Within each group, the mean unadjusted star rating is then calculated, followed by the mean adjusted star. The difference between these two parameters is the mean difference, which is shown in the rightmost column below.

Grouping of contract, based on % dual/LIS	N (Contracts)	Mean % LIS/DE in grouping	Mean unadjusted star	Mean LIS/DE-adjusted star	Mean difference in Star Rating (adjusted - unadjusted): BECOMES DISPARITY INDEX
1st-4th deciles	182	6%	3.88	3.82	**-0.06**
5th-8th deciles	182	22%	3.45	3.43	**-0.02**
9th decile	46	78%	3.12	3.15	**0.03**
10th decile	45	100%	3.25	3.30	**0.05**

The mean difference between unadjusted and adjusted stars in each group then becomes the disparity index used to adjust the star rating for all MA contracts in that group, regardless of baseline performance. For example, if a contract in the 4th decile of proportion dual/LIS scored 3.14 stars, that contract would receive an adjustment of -0.06 stars, bringing its final star rating to 3.08 stars. In contrast, if a contract in the 10th decile of proportion dual/LIS scored 3.14 stars, it would receive an adjustment of 0.05 stars, bringing its final rating to 3.19 stars.

Appendix Table 8.6: Using Indirect Standardization to Approximate the Impact of Population Grouping

Indirect standardization was used for approximating the impact of MedPAC's proposed "population grouping" approach on star performance in MA. Indirect standardization is similar to, though not identical to, population grouping. The main difference is that the population grouping approach calculates performance within each group for each contract, while indirect standardization calculates performance within each group overall, and then uses that output to calculate an "expected" performance for each contract. The MedPAC approach is simpler conceptually, but may run into greater difficulties with small numbers.

The indirect standardization method creates an expected performance for each measure based on each contract's individual patient population. For example, if the average performance on diabetes control is 40% for disabled beneficiaries and 60% for non-disabled beneficiaries, a contract that served only disabled beneficiaries would be expected to perform at 40% and a contract that served only non-disabled beneficiaries would be expected to perform at 60%.

Contracts that had both disabled and non-disabled beneficiaries would be expected to perform between 40% and 60%, as a weighted average of their populations. So, for a contract that had 30% disabled and 70% non-disabled, the expected performance would be 30%*40% + 70%*60%, or 54%.

Each contract would be judged against its expected performance. So, for the contract in the example above, the expected performance is 54%. If the actual performance was 58%, the performance ratio would be 58%/54%, or 1.07. This indicates that this contract is doing 7% better than expected given its patient population. One can then turn that ratio back into a measure rate by multiplying by the overall average performance.

This type of calculation can be applied at the measure level (as outlined above), at the domain level, or at the star level. In each case, the expected performance is simply a weighted average of the national average performance in each population group.

<u>Example of Indirect Standardization at the Star Level</u>

The calculation for each contract's adjusted rating is as follows: Let

p(c) be the proportion of the enrollees in contract c who are high social risk,

s(low) be the mean star rating for all high social risk enrollees in all MA plans,

s(other) be the mean rating for all other enrollees in all MA plans,

s(all) be the mean rating for all enrollees,

E(c) be the expected rating for contract c, and

O(c) be the actual (i.e., observed) rate for contract c.

Then the expected star rating for contract c would be

$$E(c) = [p(c) * s(low)] + [(1-p(c) * s(other)]$$

The adjusted star rating for contract c would be

$$[O(c) / E(c)] * s(all)$$

These calculations were applied at the overall star level to an illustrative sample of contracts in the table below.

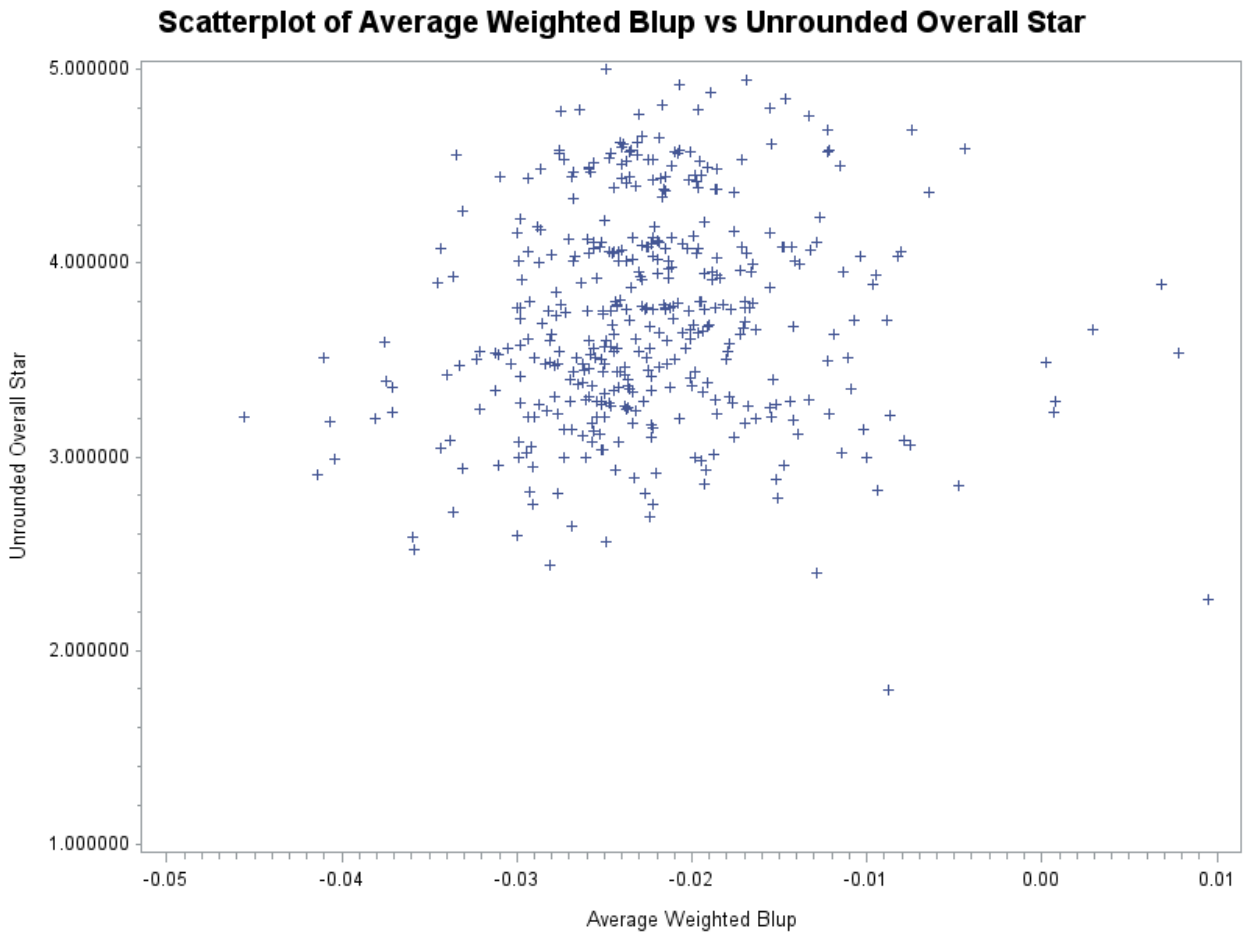
Contract	% disabled	Stars for disabled benes	Stars for non-disabled benes	Stars under current method	Stars under indirect standardization	Change in Star rating
National average (benchmarks)	**23%**	**3.6**	**4.3**	**4.2**	**4.2**	**-0.0**
A	10%	3.0	3.5	3.5	3.4	-0.1
B	50%	4.0	4.2	4.1	4.3	0.2
C	0%	n/a	4.7	4.7	4.5	-0.2
D	10%	2.5	5.0	4.8	4.6	-0.2
E	90%	3.2	3.0	3.2	3.6	0.5
F	20%	3.7	4.0	3.9	3.9	0.0
G	40%	4.0	4.0	4.0	4.1	0.1

Contract A is performing worse than average for both groups, while Contract B is performing better than average for disabled beneficiaries but worse than average for non-disabled beneficiaries. Indirect standardization penalizes Contract A for its relatively poor performance, but gives Contract B a bump up, recognizing that given its patient population it is providing "value add" in each group. Contract D, on the other hand, which serves an almost entirely non-disabled population and does very well in that group, but does exceedingly poorly for its disabled beneficiaries, has its performance adjusted down by 0.2 stars, reflecting that its performance for disabled beneficiaries is much worse than average.

Appendix Table 8.7: Methodology and Example for MA Improvement Measure

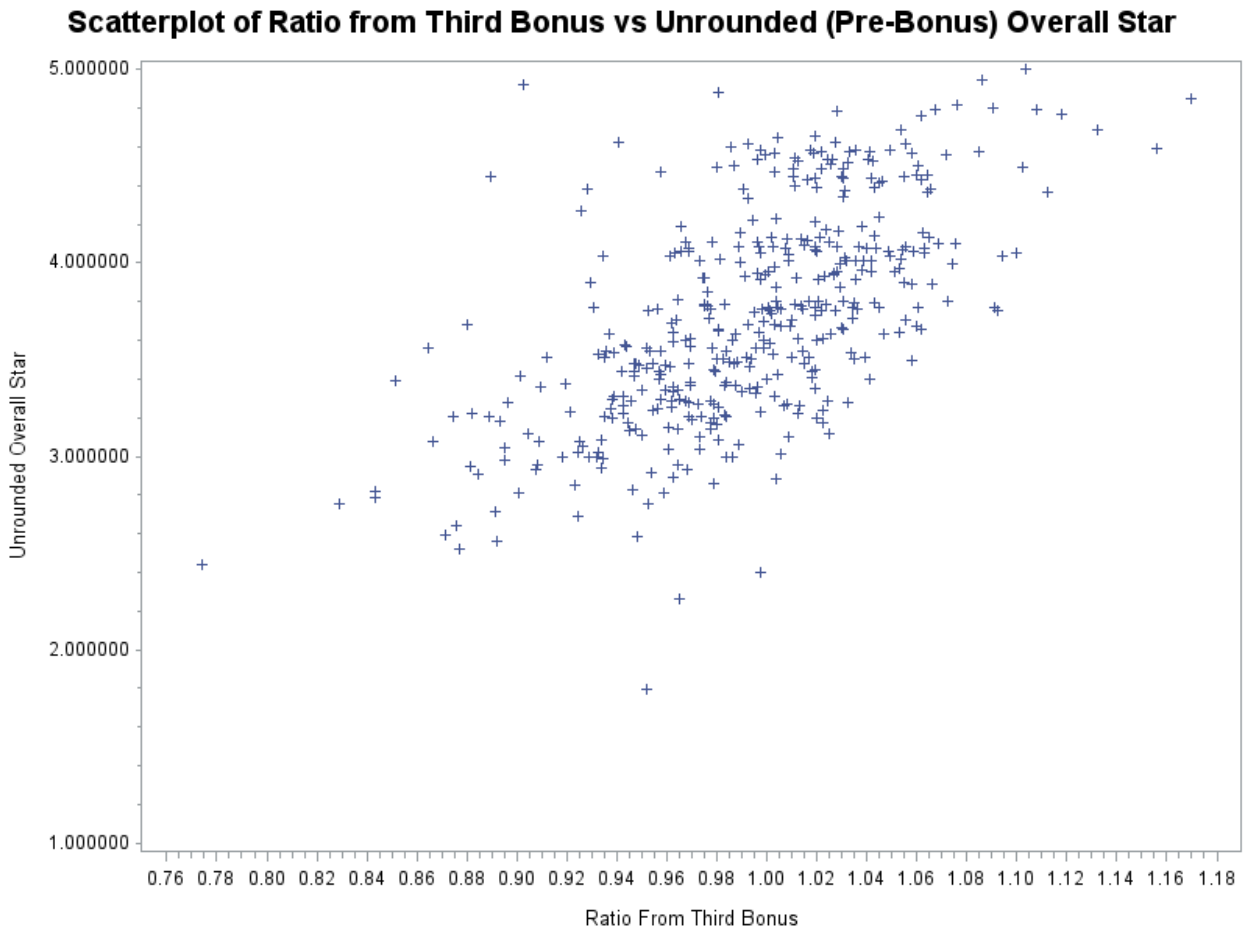
Method	Details
Current Improvement Method	In the MA program, there are 6 Outcome measures weighted 3x, 12 access/experience measures weighted 1.5x, and 17 process measures weighted 1x, as outlined in Appendix Table 8.1. The numerator for the improvement measure is the net improvement, which is a weighted sum of the number of significantly improved measures minus the number of significantly declined measures. The denominator is the weighted number of eligible measures. Example: Contract A improved on 3/6 outcome measures, 4/12 access/experience measures, and 5/17 process measures, and declined on 1 of each. Numerator is (3-1)*3 + (4-1)*1.5 + (5-1)*1 = 6 + 4.5 + 4 = 14.5 Denominator is 6*3 + 12*1.5 + 17*1 = 18 + 18 + 17 = 53 Improvement measure score is 14.5/53 = 0.27 This improvement score is converted to stars using the "relative distribution method" which uses cluster analyses to identify appropriate groupings for star assignment, a method which is used for multiple measures within MA.
Simulated upweighting of improvement	The improvement score is currently worth a total of 12.5% of the total performance score. To upweight the improvement score, it was multiplied by 2 (to double its weight to 25%) and other scores were commensurately and proportionately downweighted such that their total value dropped from 87.5% to 75% of the total score, but their relative weights within that 75% were preserved. To model a 50% weight, the improvement score was again doubled, and other measures downweighted using similar methods.

Appendix Figure 8.2: Difference between dual and non-dual (called "blup") versus overall star rating



"Blup" indicates the percent difference in performance between dual and non-dual beneficiaries, so a "blup" of -0.02 means duals did 2% worse than non-duals on average across measures.

Appendix Figure 8.3: Relationship between bonus based on relative performance for duals and overall star rating



The third bonus option was constructed as follows:

The third type of bonus focused not just on high performance for contracts with a high proportion of socially at-risk individuals, but rather for achieving high performance specifically for those socially at-risk individuals – this can be considered as one example of how an "equity bonus" might be constructed. First, a ratio of each contract's performance for dual/LIS beneficiaries versus the average performance for these beneficiaries across all contracts was created. That ratio was then multiplied by 0.5*(proportion dual/LIS) to create the star bonus. For example, if a contract achieved 3.8 stars for its dual/LIS beneficiaries, when the average was 3.2 stars, that contract would receive a bonus ratio of 3.8/3.2 or 1.19. That ratio would be multiplied by 0.5*proportion dual to create the bonus, such that if this particular contract had 100% duals it would receive the full 0.5 star bonus. If it had 75% duals it would receive 0.5*0.75, or 0.44 stars.

Appendix Table 8.8a: Average Unweighted Change in Stars for Each Modeled Option

	Overall	High-Dual Contracts (top quintile)	Low-Dual (all other) Contracts
Original Mean Stars	**3.73**	**3.50**	**3.78**
Direct Adjustment	+0.01	+0.02	0.00
Categorical Adjustment Index	+0.02	+0.06	+0.01
Stratification	-0.20	-0.11	-0.22
Population Grouping: Measure Rate	-0.05	+0.03	-0.06
Population Grouping: Star Level	+0.03	+0.19	0.00
Reward Improvement 25%	+0.01	+0.05	+0.01
Scaled Achievement Bonus	+0.12	+0.32	+0.08
Scaled Improvement Bonus	+0.04	+0.14	+0.02
Socially At-Risk High-Performance Bonus	+0.07	+0.17	+0.05

Appendix Table 8.9a: Net Impact of Policy Options: Percent of Contracts that Newly Reach 4 Stars

	Overall	High-Dual Contracts (top quintile)	Low-Dual (all other) Contracts
Percent with 4+ stars, current program	**48%**	**26%**	**53%**
Direct Adjustment	3%	0%	4%
Categorical Adjustment Index	1%	3%	0.3%
Stratification	5%	24%	0%
Population Grouping: Measure Rate	0%	1%	0%
Population Grouping: Star Level	3%	12%	1%
Reward Improvement 25%	4%	9%	3%
Scaled Achievement Bonus	5%	20%	2%
Scaled Improvement Bonus	5%	17%	1%
Socially At-Risk High-Performance Bonus	4%	12%	3%

Appendix Table 8.9b: Net Impact of Policy Options: Percent of Contracts that Newly Drop Below 4 Stars

	Overall	High-Dual Contracts (top quintile)	Low-Dual (all other) Contracts
Percent with 4+ stars, current program	**48%**	**26%**	**53%**
Direct Adjustment	2%	1%	3%
Categorical Adjustment Index	0.2%	0%	0.3%
Stratification	10%	3%	12%
Population Grouping: Measure Rate	1%	0%	1%
Population Grouping: Star Level	3%	0%	4%
Reward Improvement 25%	1%	0%	1%
Scaled Achievement Bonus	0%	0%	0%
Scaled Improvement Bonus	0%	0%	0%
Socially At-Risk High-Performance Bonus	0%	0%	0%

Appendix Chapter 9: The Medicare Shared Savings Program

The main purpose of this technical appendix is to describe and document the analysis done to explore the relationship between beneficiary and provider social risk factors and the current Medicare Shared Savings Program.

Social Risk Variables

Beneficiary social risk factors

Any beneficiary attributed to an ACO, as indicated by the beneficiary-alignment file, was assigned a set of indicator variables based on beneficiary social risk factors. Table 1 displays the data sources and definitions of these social risk factors used throughout the analysis. These variables are referred as "beneficiary social risk factors" in the rest of chapter.

Table 1. Beneficiary social and related risk factors

Variables	Descriptions	Data source
Dual	Indicator of the beneficiary's dual eligibility in the first month of CY 2014. If the DUAL_MDCR variable is part of the list below , the beneficiary is deemed dual eligible: • 01 = Eligible is entitled to Medicare- QMB only • 02 = Eligible is entitled to Medicare- QMB AND Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) • 03 = Eligible is entitled to Medicare- SLMB only • 04 = Eligible is entitled to Medicare- SLMB AND Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) • 05 = Eligible is entitled to Medicare- QDWI • 06 = Eligible is entitled to Medicare- Qualifying individuals • 07 = Missing in latest data dictionary and shows up rarely (<.001%); consulting with analogous MAX variable suggested that this is the same as 06 • 08 = Eligible is entitled to Medicare- Other Full Dual Eligibles (Non QMB, SLMB,QWDI or QI)with Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) • 09 = Eligible is entitled to Medicare – Other Dual Eligibles but without Medicaid coverage, includes Pharmacy Plus and 1115 drug-only demonstration.	Enrollment Database

Low ZCTA income	Indicator of whether the beneficiary's residence as on 1/1/2014 is in a below-national-median zip code tabulation (ZCTA) area. All ZIP Code Tabulation Areas (ZCTAs) were ranked based on their American Community Survey (ACS) 5-year estimates of median household income. A cut-off for the lowest quintile of ZCTA-level income was determined using these rankings, weighted by the number of households in each ZCTA. ZCTAs that had a median household income below the cut-off were "low-income." The beneficiary zip code of residency as of 1/1/2014 was used to determine whether the beneficiary was flagged as "low-income"	Enrollment Database, 5-year ACS estimates, UDS Mapper Zip to ZCTA crosswalk (2014)
Black	Beneficiary has a Research Triangle Institute (RTI) race code of 2: "Black (or African-American)"	Master Beneficiary Summary File
Hispanic	Beneficiary has RTI race code of 5: "Hispanic"	Master Beneficiary Summary File
Rural	Indicator of whether the beneficiary's residence as on 1/1/2014 is in a non-core-based statistical area (CBSA) county	Enrollment Database
Disabled	Indicator of the beneficiary's original entitlement reason for Medicare being disability	Enrollment Database

ACO social and related risk factors

Any ACO in the analytic file is assigned an "ACO social risk factor" according to the proportion of its attributed beneficiaries with that social risk factor. The following procedure was applied to determine ACO social risk factors:

1. For each ACO, calculate the proportion of beneficiaries with the social risk factor.
2. Use this proportion to rank all ACOs with at least 1 beneficiary.
3. Flag the ACO social risk factor as 1 if the ACO is in the top quintile of proportion of attributed beneficiaries with the social risk factor. The steps above were applied for all the ACO social risk factors.

Regression models with social risk factor methodology as the primary predictor

Hospital-wide, all-cause, unplanned readmissions measure

Regression analyses for the readmission measure seek to explore the relationship between beneficiary / ACO social risk factors, and the readmission measure outcome. The analyses also evaluate how much predictive power the social risk factors have, when included together with the current risk-adjustment variables.

The readmission regression analyses are run on 5 cohort-specific index-stay level files separately, with a 0 or1 outcome for each index-stay, indicating whether or not the index stay was followed by an unplanned readmission within 30 days. Logistic link functions are applied to model the 0/1 outcomes, therefore all the coefficient estimates are reported as odds ratios.

The analyses were done in 3 parts, in order to explore the impact of social risk factors at different levels. The regressions included the following covariates:

Part 1. Beneficiary social risk factor alone, with/ without CMS-defined risk adjustment variables

Part 2. ACO social risk factor alone, with/ without CMS-defined risk adjustment variables

Part 3. Beneficiary and ACO social risk factors combined, with/without CMS defined risk adjustment variables.

The relationships were explored using Random Effect (RE) models, with ACO-level random intercepts, in order to evaluate the within-ACO effects of each social risk factor. The RE model also reflects the risk-adjustment methodology applied by CMS for the hospital-wide, all-cause, unplanned rate.

Acute and chronic ambulatory care sensitive condition (ACSC) measures

The ACSC measure regressions explore the relationship between each ACSC individual observed measure outcome and the beneficiary/ACO social risk factors. The regression analyses also report odds ratios for each social risk factor, with or without CMS risk-adjustment variables included.

A hierarchical logistic model is used (with or without risk adjustment). It models the log-odds of COPD/HF (using risk adjustment variables as predictors if applicable), and facility-specific intercepts. During certain phases of this analysis, patient SES factors and hospital characteristics (structural and SES) will be included in the model, which means they are added as predictors:

$$\widehat{ACSC_{Beneficiary}} = \hat{\alpha}_0 + \left(\hat{\beta}_1 SES_{bene}\right) + \left[\hat{\beta}_2 risk_{vars}\right] + \hat{\delta} ACO_{id}$$

$$\widehat{ACSC_{Beneficiary}} = \hat{\alpha}_0 + \left(\hat{\beta}_1 SES_{aco}\right) + \left[\hat{\beta}_2 risk_{vars}\right] + \hat{\delta} ACO_{id}$$

$$\widehat{ACSC_{Beneficiary}} = \hat{\alpha}_0 + \left(\hat{\beta}_1 SES_{bene}\right) + \left(\hat{\beta}_1 SES_{aco}\right) + \left[\hat{\beta}_2 risk_{vars}\right] + \hat{\delta} ACO_{id}$$

The facility-specific intercepts ($\hat{\delta} ACO_{id}$) account for within facility correlation of readmission risk.

The analyses were done in 3 parts, in order to explore the impact of social risk factors at different levels. The regressions included the following covariates:

Part 1. Beneficiary social risk factor alone, with/ without CMS-defined risk adjustment variables

Part 2. ACO social risk factor alone, with/ without CMS-defined risk adjustment variables

Part 3. Beneficiary and ACO social risk factors combined, with/without CMS defined risk adjustment variables.

Note: currently the regression analyses are being updated to more closely align with the manner in which these are applied in the ACO program.

Simulation Methodologies

All of the simulation analyses follow the CMS score calculation guide lines.

Domain	Number of measures
Patient/Caregiver Experience	7
Care Coordination/Patient Safety	6 (one measure, #11 "EHR Incentive Payment qualification" is double weighted
Preventive Health	8
At-Risk Population Diabetes/Hypertension/IVD/HF/CAD	6 (including composite measures for diabetes and CAD)

Direct social risk factor adjustment for readmission and ACSC measures

This simulation is applied to readmission and ACSC measures directly at the measure level. The beneficiary dual/high complexity factors are added to CMS' existing risk-adjustment models, producing new risk-standardized readmission rates (RSRRs) and new risk-adjusted ACSC measure outcomes. The new measure outcomes are rolled-up to final quality scores using MSSP methodology.

Direct HCC risk score adjustment for ACSC measures

This simulation is applied to ACSC measures directly at the measure level. The beneficiary's HCC risk score is added to CMS' existing risk-adjustment models, producing new risk-adjusted ACSC measure outcomes. The new measure outcomes are rolled-up to final quality scores using MSSP methodology.

Note: These results are pending, although they will only affect 2 of the 33 measures.

Stratification based on social risk factor

The stratification simulation was applied to the quality score only. Instead of standardizing the quality composite score among all ACOs, ACOs are grouped into smaller groups (e.g., quintiles) based on social risk factor (see below), and then standardize the quality composite score within each group.

1. 5 groups based on quintiles of each ACO's proportion of dual beneficiaries
2. 2 groups based on the top quintile of each ACO's proportion of dual beneficiaries and the bottom 80th percentile

The final quality score is based on the measure cutoffs within each group.

Rewarding Improvement

Per the June 2015 Medicare Physician Fee Schedule Final Rule, CMS will begin rewarding ACOs for quality improvement by adding points to their domain scores. ACOs may earn up to 4 points in each domain based on statistically significant quality improvement, up to the maximum available points in

each domain. For this simulation, domain scores were recalculated incorporating quality points for significant year-over-year quality improvement for all eligible ACOs (as described in the rule).

Provide a bonus for high performance for ACOs that serve a high proportion of high social risk patients
The bonus simulation was applied to final ACO quality scores. Two types of bonus options were explored, based on whether the ACO was a high social risk ACO, and the proportion of beneficiaries with the social risk factor within the ACO.

1. Direct bonus to savings
   Under this simulation, ACOs that were eligible for shared savings (i.e., those meeting the minimum savings rate and quality threshold) and that had a high proportion of high-social-risk patients got an additional bonus to raise the percent of their savings that they kept (shared savings). For an ACO eligible for shared savings and with a dual rate in the top quintile, the ACO's shared savings rate was multiplied by 1 + (%dual/2), so, for example, an ACO with 80% duals would have its shared savings rate multiplied by 1+ (0.8/2), or 1.4.
2. Improvement bonus
   In addition to the "rewarding improvement" methodology, high-dual ACOs were rewarded an additional share of bonus points (up to 4), proportional to the rate of dual eligible beneficiaries.

Regional Benchmarking
Per the proposed rule, each ACO's benchmark would be a blend of its own historical spending and the difference between the ACO's own spending and spending in the ACO's region. In the second agreement period, the weight on the regional expenditures-based component of the benchmark is proposed to be 35%, increasing to 70% in third and subsequent agreement periods. Additionally, a regional expenditure growth rate would be used in place of the national expenditure trend when trending forward benchmark years, and in place of the national growth amount for updating the ACO's historical benchmark in each performance year.

Supplemental Tables and Figures

Appendix Table 9.1a-c: Detailed Comparisons of Beneficiary Characteristics, 2014

A. FFS versus ACO population, 2014

	Medicare FFS population*		All ACOs	
	# of Benes	% of Total FFS Benes	# of Benes	% of Total ACO Benes
Total Beneficiaries	27,574,226	100.0%	5,322,292	100.0%
Dual Eligible	5,960,304	21.6%	917,144	17.2%
Full Dual	4,475,230	16.2%	684,625	12.9%
Partial Dual	1,485,074	5.4%	232,519	4.4%
Race				
Black	2,768,594	10.0%	450,806	8.5%
Hispanic	1,716,499	6.2%	274,330	5.2%
Rural (Non-MSA)	6,934,061	25.1%	809,105	15.2%
Disabled	7,229,032	26.2%	1,141,190	21.4%
ZCTA Level Income				
Unknown	110,089	0.4%	5,446	0.1%
0 - 20k	4,790,784	17.4%	639,672	12.0%
20 - 25k	7,769,833	28.2%	1,219,132	22.9%
25k - 30k	5,754,346	20.9%	1,159,899	21.8%
30k - 40k	6,254,635	22.7%	1,525,418	28.7%
>40k	2,894,539	10.5%	772,725	14.5%
Gender				
Female	12,472,601	45.2%	2,271,479	42.7%
Male	15,101,625	54.8%	3,050,812	57.3%
Age Summary				
Mean	70.5		71.5	
Standard Dev.	12.9		11.9	

Age Categories				
0 - 64	5,329,647	19.3%	954,945	17.9%
65 - 69	6,709,971	24.3%	1,230,756	23.1%
70 - 74	5,232,912	19.0%	1,045,051	19.6%
75 - 79	3,966,725	14.4%	809,749	15.2%
80 - 84	2,976,265	10.8%	613,647	11.5%
85 +	3,358,706	12.2%	668,144	12.6%
"Community" Risk Score				
Mean	1.120		1.155	
Standard Dev.	1.094		1.074	
HCC Comorbidity (# of HCCs in 2014)				
Unknown	15,172	0.1%	269	0.0%
0 HCCs	10,739,563	38.9%	1,857,060	34.9%
1 HCC	6,315,848	22.9%	1,281,871	24.1%
2 HCCs	4,002,591	14.5%	842,829	15.8%
3 - 5 HCCs	4,833,474	17.5%	1,010,010	19.0%
6 - 9 HCCs	1,390,978	5.0%	278,559	5.2%
10+ HCCs	276,600	1.0%	51,694	1.0%

B. High Social Risk vs. Other ACOs, 2014: Dual, Low-income ZCTA, Black

	High-Dual	Non-High-Dual	Low-income ZCTA	Non-low-income ZCTA	High-Black	Non-High-Black
Total Beneficiaries						
Dual Eligible	40.7%	13.7%	24.1%	16.3%	22.8%	16.2%
Full Dual	31.6%	10.0%	15.3%	12.5%	16.5%	12.2%
Partial Dual	9.1%	3.6%	8.8%	3.7%	6.3%	4.0%
Race						
Black	11.5%	8.0%	10.4%	8.2%	23.4%	5.6%
Hispanic	13.2%	3.9%	9.8%	4.5%	5.0%	5.2%
Rural (Non-MSA)	22.2%	14.1%	32.7%	12.7%	12.2%	15.8%

Disabled	31.2%	20.0%	28.9%	20.4%	27.3%	20.3%
ZCTA Level Income						
Unknown	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
0 - 20k	24.8%	10.1%	36.0%	8.6%	17.8%	10.9%
20 - 25k	27.4%	22.2%	39.7%	20.5%	23.7%	22.7%
25k - 30k	20.7%	22.0%	15.6%	22.7%	19.1%	22.3%
30k - 40k	20.0%	30.0%	7.8%	31.7%	26.0%	29.2%
>40k	7.0%	15.7%	0.8%	16.5%	13.3%	14.7%
Gender						
Female	42.7%	42.7%	42.8%	42.7%	42.1%	42.8%
Male	57.3%	57.3%	57.2%	57.3%	57.9%	57.2%
Age Summary						
Mean	69.7	71.7	70.3	71.6	70.0	71.8
Standard Dev.	13.6	11.6	12.5	11.8	12.6	11.7
Age Categories						
0 - 64	25.6%	16.8%	22.6%	17.3%	22.9%	17.0%
65 - 69	20.1%	23.6%	21.7%	23.3%	22.9%	23.2%
70 - 74	17.1%	20.0%	18.7%	19.8%	18.7%	19.8%
75 - 79	13.9%	15.4%	14.8%	15.3%	14.2%	15.4%
80 - 84	10.8%	11.6%	11.0%	11.6%	10.3%	11.8%
85 +	12.5%	12.6%	11.1%	12.8%	11.0%	12.9%
"Community" Risk Score						
Mean	1.289	1.135	1.193	1.150	1.210	1.145
Standard Dev.	1.168	1.058	1.080	1.073	1.131	1.062
HCC Comorbidity (# of HCCs in 2014)						
Unknown	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0 HCCs	32.4%	35.3%	33.2%	35.1%	33.3%	35.2%
1 HCC	23.3%	24.2%	23.9%	24.1%	23.8%	24.1%
2 HCCs	16.3%	15.8%	16.2%	15.8%	16.1%	15.8%
3 - 5 HCCs	20.6%	18.7%	20.1%	18.8%	19.8%	18.8%
6 - 9 HCCs	6.1%	5.1%	5.6%	5.2%	5.8%	5.1%
10+ HCCs	1.3%	0.9%	1.0%	1.0%	1.2%	0.9%

C. High Social Risk vs. Other ACOs, 2014: Hispanic, Rural, Disabled

	High-Hispanic	Non-High-Hispanic	High-Rural	Non-High-Rural	High-Disabled	Non-High-Disabled
Total Beneficiaries	717,860	4,604,432	1,085,654	4,236,638	785,582	4,536,710
Dual Eligible	29.7%	15.3%	20.7%	16.3%	29.6%	15.1%
Full Dual	24.3%	11.1%	13.9%	12.6%	21.7%	11.3%
Partial Dual	5.4%	4.2%	6.8%	3.7%	7.8%	3.8%
Race						
Black	10.5%	8.1%	5.6%	9.2%	12.5%	7.8%
Hispanic	21.5%	2.6%	2.5%	5.8%	8.2%	4.6%
Rural (Non-MSA)	5.8%	16.7%	48.7%	6.6%	22.1%	14.0%
Disabled	24.1%	21.0%	25.6%	20.4%	34.3%	19.2%
ZCTA Level Income						
Unknown	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
0 - 20k	19.7%	10.8%	17.4%	10.6%	26.0%	9.6%
20 - 25k	22.6%	23.0%	33.2%	20.3%	29.7%	21.7%
25k - 30k	16.9%	22.6%	27.3%	20.4%	21.9%	21.8%
30k - 40k	24.2%	29.3%	18.6%	31.2%	18.1%	30.5%
>40k	16.4%	14.2%	3.5%	17.3%	4.3%	16.3%
Gender						
Female	42.4%	42.7%	43.4%	42.5%	43.3%	42.6%
Male	57.6%	57.3%	56.6%	57.5%	56.7%	57.4%
Age Summary						
Mean	70.9	71.6	70.8	71.6	68.6	72.0
Standard Dev.	12.6	11.8	12.4	11.8	13.7	11.5
Age Categories						
0 - 64	20.5%	17.5%	20.5%	17.3%	28.4%	16.1%
65 - 69	22.1%	23.3%	22.2%	23.4%	20.9%	23.5%
70 - 74	18.9%	19.7%	19.0%	19.8%	16.8%	20.1%
75 - 79	14.9%	15.3%	14.9%	15.3%	13.1%	15.6%
80 - 84	11.2%	11.6%	11.3%	11.6%	10.0%	11.8%

85 +	12.4%	12.6%	12.1%	12.7%	10.8%	12.9%
"Community" Risk Score						
Mean	1.286	1.135	1.118	1.165	1.206	1.146
Standard Dev.	1.193	1.053	1.015	1.089	1.100	1.069
HCC Comorbidity (# of HCCs in 2014)						
Unknown	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0 HCCs	32.2%	35.3%	35.9%	34.6%	33.7%	35.1%
1 HCC	22.7%	24.3%	24.7%	23.9%	23.8%	24.1%
2 HCCs	16.2%	15.8%	15.7%	15.9%	16.2%	15.8%
3 - 5 HCCs	21.2%	18.6%	18.1%	19.2%	19.7%	18.9%
6 - 9 HCCs	6.3%	5.1%	4.8%	5.4%	5.6%	5.2%
10+ HCCs	1.4%	0.9%	0.8%	1.0%	1.1%	1.0%

Appendix Table 9.2: Detailed ACO Characteristics, 2014

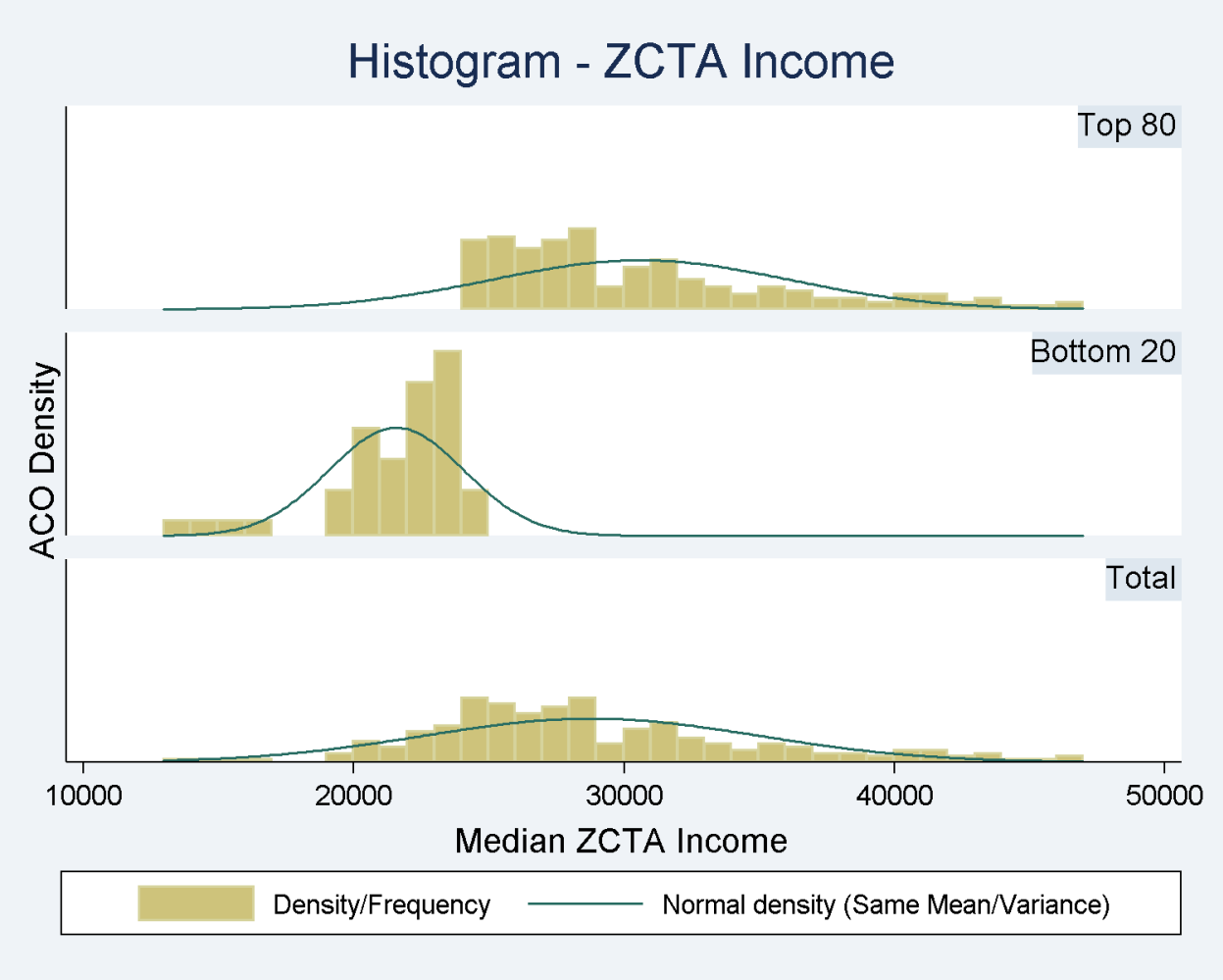
	Overall	High-Dual	Low-ZCTA Income	High-Black	High-Hispanic	High-Rural	High-Disabled
N	333	66	66	66	66	66	66
ACO Size							
Small (0 - 10,000 enrollees)	44.7%	66.7%	72.7%	56.1%	71.2%	47.0%	54.5%
Medium (10,001 - 20,000)	33.0%	24.2%	19.7%	28.8%	18.2%	27.3%	30.3%
Large (20,001 + enrollees)	22.2%	9.1%	7.6%	15.2%	10.6%	25.8%	15.2%
Provider Size							
Small (0 - 99 providers)	32.7%	37.9%	57.6%	37.9%	43.9%	34.8%	25.8%
Medium (100 - 500 providers)	37.5%	33.3%	27.3%	28.8%	33.3%	36.4%	31.8%
Large (501 + providers)	29.7%	28.8%	15.2%	33.3%	22.7%	28.8%	42.4%
Ownership							
Has an associated non-profit hospital	42.0%	45.5%	28.8%	37.9%	34.8%	56.1%	56.1%
Does NOT have a non-profit hospital	58.0%	54.5%	71.2%	62.1%	65.2%	43.9%	43.9%
Has an associated for-profit hospital	14.1%	16.7%	6.1%	15.2%	16.7%	12.1%	21.2%

Does NOT have a for-profit hospital	85.9%	83.3%	93.9%	84.8%	83.3%	87.9%	78.8%
Has an associated public hospital	24.9%	27.3%	19.7%	27.3%	18.2%	37.9%	37.9%
Does NOT have a public hospital	75.1%	72.7%	80.3%	72.7%	81.8%	62.1%	62.1%
Speciality							
Has <= 50% "Family Practice" providers	59.8%	45.5%	47.0%	54.5%	30.3%	65.2%	54.5%
Has > 50% "Family Practice" providers	40.2%	54.5%	53.0%	45.5%	69.7%	34.8%	45.5%
Has <= 10% "Medical Specialty" prov	42.0%	57.6%	60.6%	47.0%	51.5%	60.6%	63.6%
Has > 10% "Medical Specialty" prov	58.0%	42.4%	39.4%	53.0%	48.5%	39.4%	36.4%
Has <= 10% "Surgery Specialty" prov	68.2%	80.3%	77.3%	78.8%	75.8%	69.7%	75.8%
Has > 10% "Surgery Specialty" prov	31.8%	19.7%	22.7%	21.2%	24.2%	30.3%	24.2%
Has <= 10% "Obstetrics-Gynecology"	93.1%	93.9%	87.9%	95.5%	92.4%	95.5%	95.5%
Has > 10% "Obstetrics-Gynecology"	6.9%	6.1%	12.1%	4.5%	7.6%	4.5%	4.5%
Has <= 10% "Hospital based" prov	61.0%	71.2%	74.2%	65.2%	72.7%	65.2%	68.2%
Has > 10% "Hospital based" prov	39.0%	28.8%	25.8%	34.8%	27.3%	34.8%	31.8%
Has <= 10% "Psychiatry" providers	96.1%	93.9%	90.9%	97.0%	92.4%	98.5%	97.0%
Has > 10% "Psychiatry" providers	3.9%	6.1%	9.1%	3.0%	7.6%	1.5%	3.0%
Teaching Affiliation							
Yes	7.8%	10.6%	7.6%	13.6%	6.1%	7.6%	12.1%
No/Unknown	92.2%	89.4%	92.4%	86.4%	93.9%	92.4%	87.9%
Region							
Northeast	20.7%	30.3%	10.6%	16.7%	16.7%	21.2%	25.8%
Midwest	18.3%	4.5%	9.1%	15.2%	3.0%	15.2%	19.7%
South	39.6%	40.9%	63.6%	62.1%	36.4%	42.4%	42.4%
West	14.4%	13.6%	9.1%	6.1%	31.8%	12.1%	4.5%
Spanning across	6.9%	10.6%	7.6%	0.0%	12.1%	9.1%	7.6%
Agreement Start Date							
1-Apr-12	7.8%	6.1%	9.1%	4.5%	12.1%	9.1%	7.6%
1-Jul-12	25.5%	31.8%	21.2%	22.7%	22.7%	31.8%	30.3%
1-Jan-13	30.9%	24.2%	37.9%	22.7%	22.7%	30.3%	24.2%

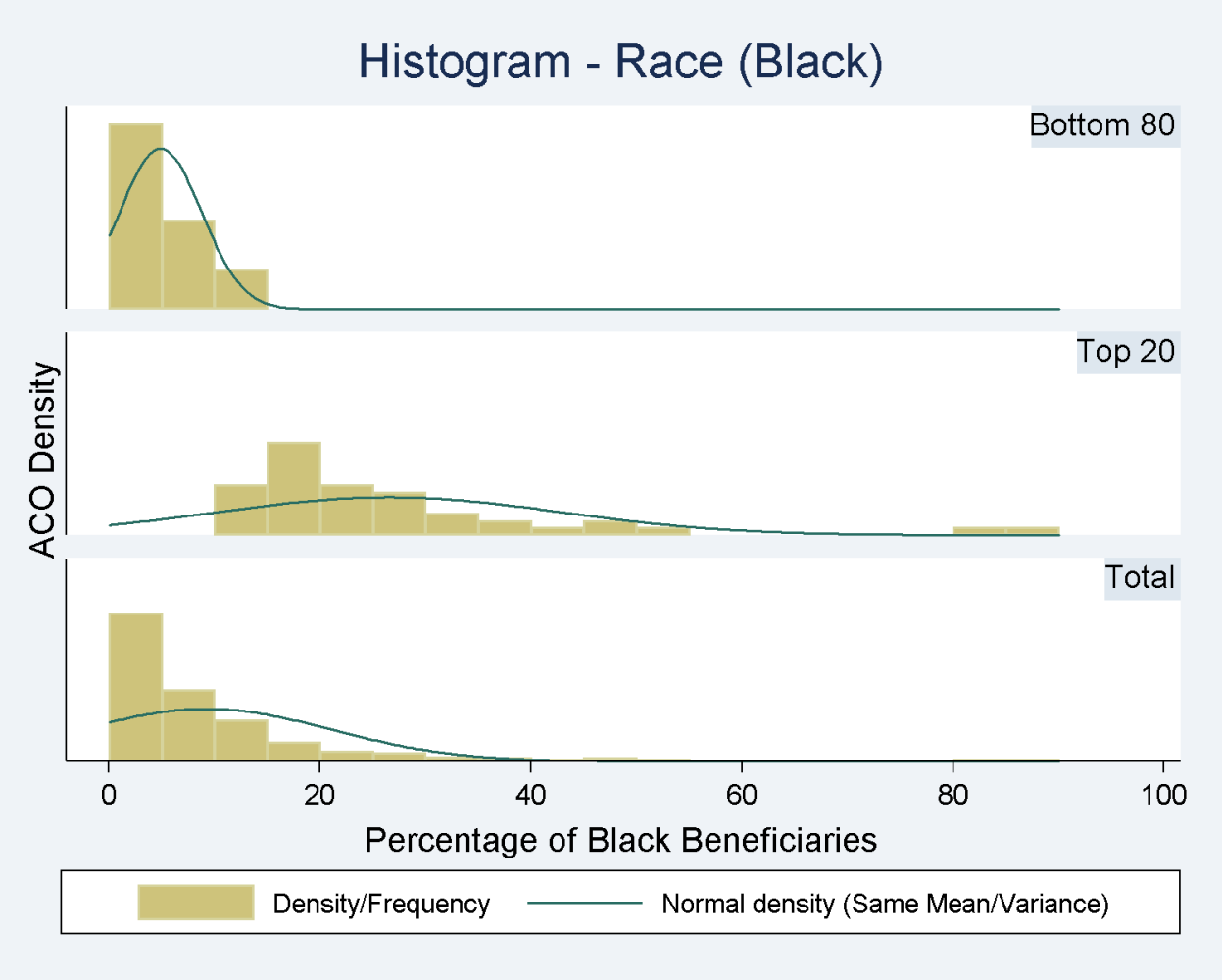
1-Jan-14	35.7%	37.9%	31.8%	50.0%	42.4%	28.8%	37.9%
Has a Hospital In The Network							
No	43.2%	31.8%	48.5%	48.5%	45.5%	28.8%	24.2%
Yes	56.8%	68.2%	51.5%	51.5%	54.5%	71.2%	75.8%

Appendix Figure 9.1a-e: Distribution of Social Risk Factors

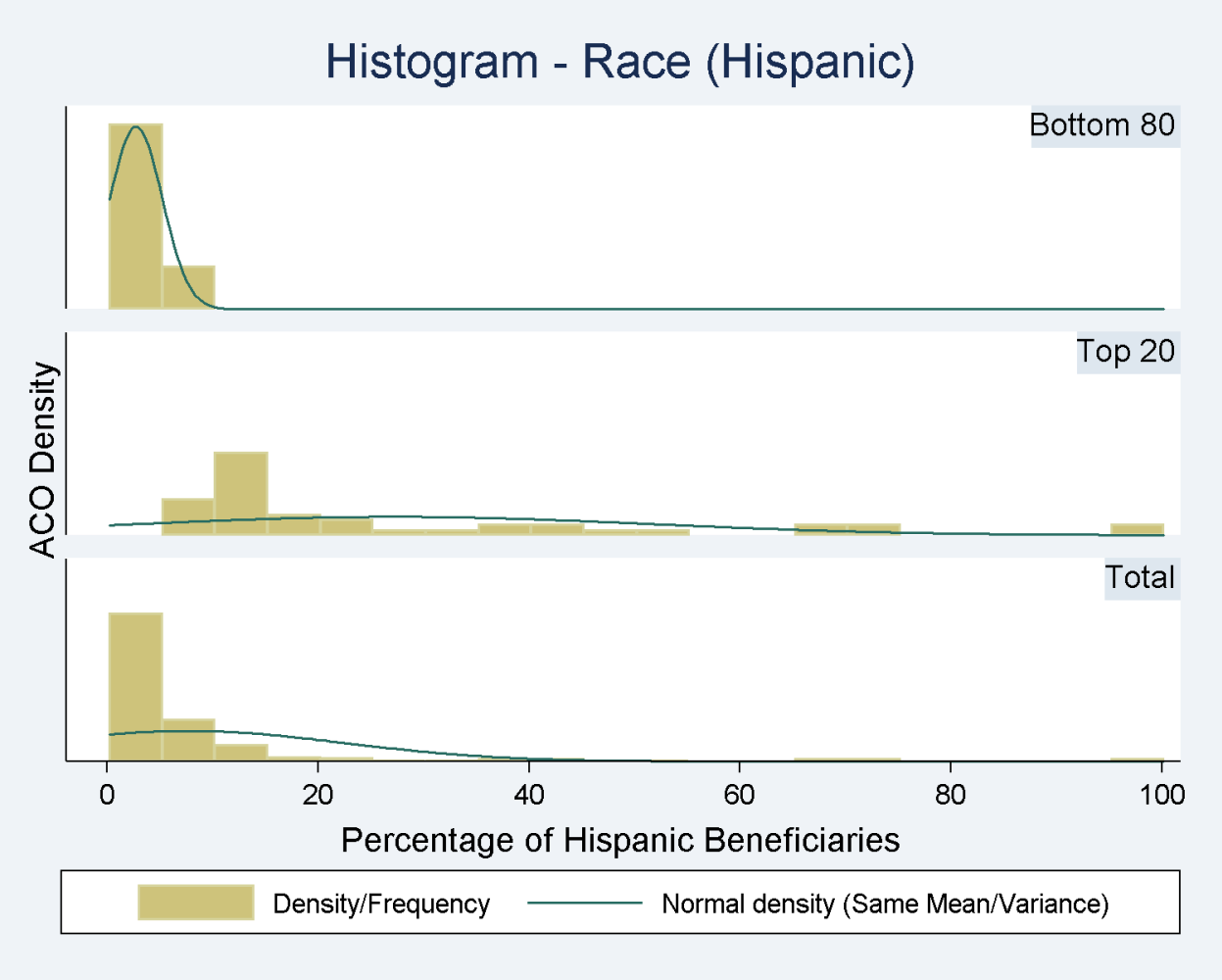
A. ZCTA Income



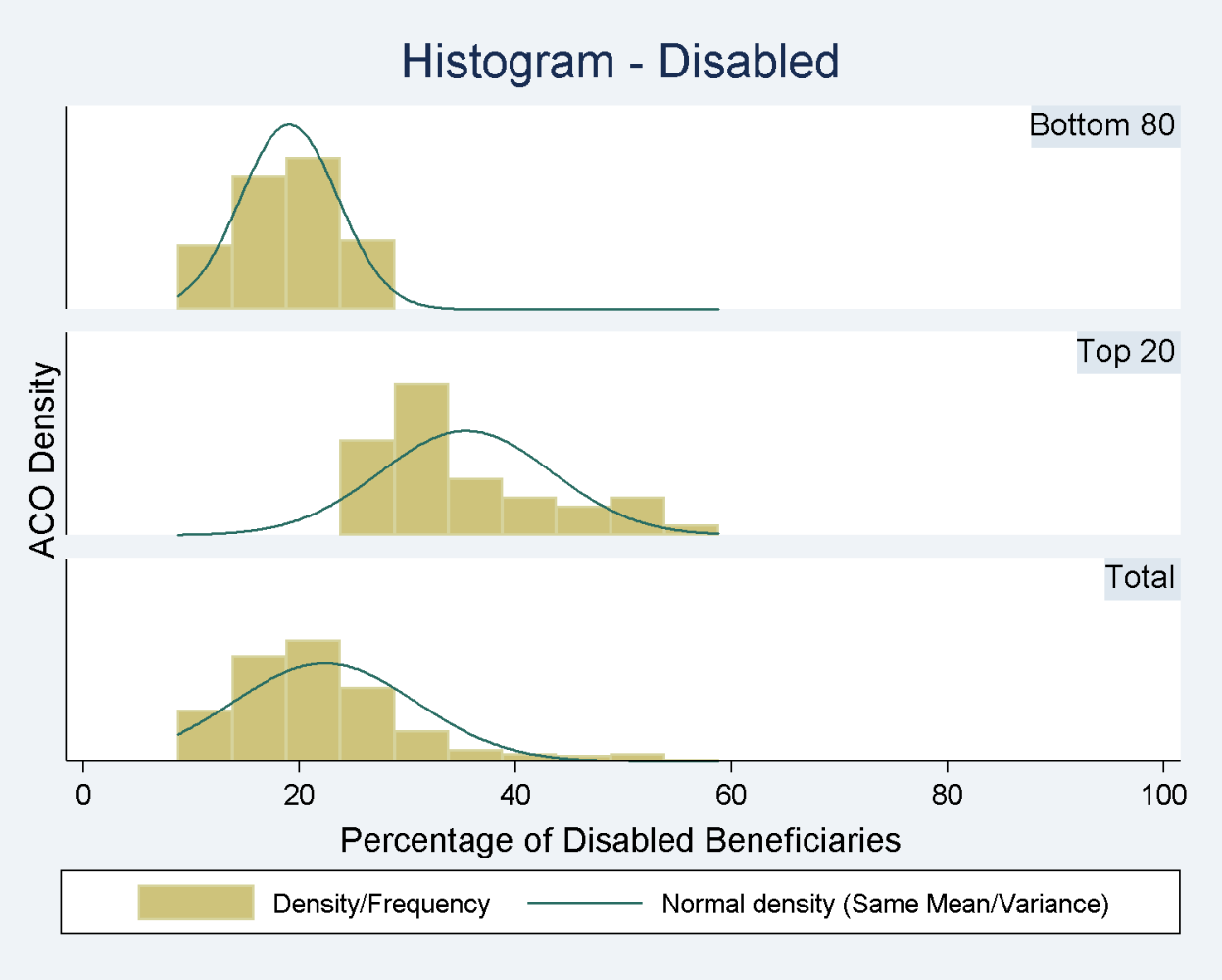
B. Black


Histogram - Race (Black)
Bottom 80
Top 20
Total
ACO Density
0
20
40
60
80
100
Percentage of Black Beneficiaries
Density/Frequency
Normal density (Same Mean/Variance)

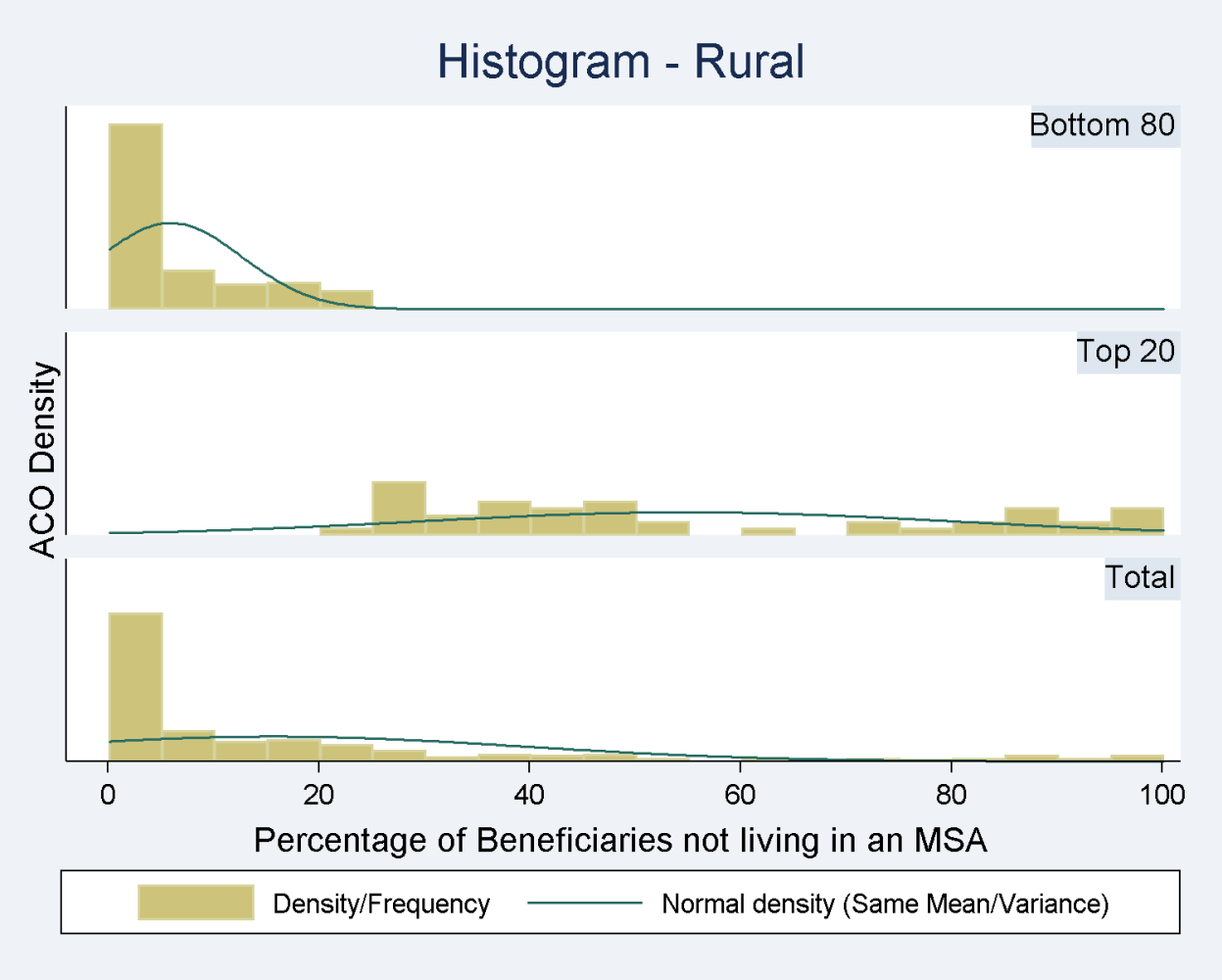
C. Hispanic


Histogram - Race (Hispanic)
Bottom 80
Top 20
Total
ACO Density
0
20
40
60
80
100
Percentage of Hispanic Beneficiaries
Density/Frequency
Normal density (Same Mean/Variance)

D. Disabled


Histogram - Disabled
Bottom 80
Top 20
Total
ACO Density
0
20
40
60
80
100
Percentage of Disabled Beneficiaries
Density/Frequency
Normal density (Same Mean/Variance)

E. Rural


Histogram - Rural
Bottom 80
Top 20
Total
ACO Density
0
20
40
60
80
100
Percentage of Beneficiaries not living in an MSA
Density/Frequency
Normal density (Same Mean/Variance)

Appendix Table 9.3a-c: ACO Social Risk Factor Overlap

2014 - Correlation between the proportion of socially at-risk beneficiaries

Social Risk Factor	Dual	Income	Black	Hispanic	Rural	Disabled
Dual	1.000	-0.288	0.267	0.375	0.059	0.610
Income	-0.288	1.000	-0.009	-0.238	-0.404	-0.455
Black	0.267	-0.009	1.000	-0.066	-0.111	0.449
Hispanic	0.375	-0.238	-0.066	1.000	-0.181	0.150
Rural	0.059	-0.404	-0.111	-0.181	1.000	0.240
Disabled	0.610	-0.455	0.449	0.150	0.240	1.000

2014 - Overlap between the top quintile social risk ACOs

Social Risk Factor	Overlap					
	Dual	Income	Black	Hispanic	Rural	Disabled
Dual	66	27	23	34	21	38
Income	27	66	18	15	27	30
Black	23	18	66	14	11	26
Hispanic	34	15	14	66	4	18
Rural	21	27	11	4	66	25
Disabled	38	30	26	18	25	66

Rows are mutually exclusive

2014 - Number of overlapping social risk ACOs

	Number of ACOs	
Total	333	(100.0%)
No Top SES Quintile	130	(39.0%)
1 Top SES Quintile	103	(30.9%)
2 Top SES Quintiles	45	(13.5%)
3 Top SES Quintiles	24	(7.2%)
4 Top SES Quintiles	24	(7.2%)
5 Top SES Quintiles	7	(2.1%)
6 Top SES Quintiles	0	(0.0%)

Appendix Table 9.4a-b: Median Regression Results – Median MSSP Performance Overall and for High Social Risk ACOs (2014)

A. Dual, Disabled, Black

Quality Measure			Pct Dual Eligible			Pct Disabled			Pct Black		
			Median Performance, Top Quintile	Median Regression		Median Performance, Top Quintile	Median Regression		Median Performance, Top Quintile	Median Regression	
	Description	Median		Difference (Beta)	P > |t|		Difference (Beta)	P > |t|		Difference (Beta)	P > |t|
ACO-1	CAHPS: Timely care, appts, info	80.6	78.6	-2.320	0.000	79.0	-1.920	0.001	79.7	-1.120	0.072
ACO-2	CAHPS: Provider communication	92.7	91.8	-1.010	0.000	92.1	-0.690	0.008	92.4	-0.320	0.232
ACO-3	CAHPS: Patient rating of provider	91.9	91.2	-0.820	0.004	91.4	-0.610	0.027	91.4	-0.560	0.041
ACO-4	CAHPS: Access to specialists	84.1	83.3	-1.080	0.007	83.9	-0.360	0.349	84.1	0.080	0.833
ACO-5	CAHPS: Health promotion / education	58.2	58.9	0.770	0.230	57.9	-0.550	0.373	58.2	-0.020	0.975
ACO-6	CAHPS: Shared decision making	74.7	73.9	-0.900	0.026	74.3	-0.490	0.230	73.2	-1.740	0.000
ACO-7	CAHPS: Health status / fxl status	71.3	69.6	-2.020	0.000	69.7	-1.870	0.000	70.3	-1.280	0.002
ACO-8	Risk-standardized all-condition readmission	15.1	15.4	0.350	0.005	15.2	0.150	0.239	15.3	0.270	0.023
ACO-9	ACSC: COPD	1.0	1.3	0.280	0.000	1.1	0.070	0.319	1.3	0.280	0.000
ACO-10	ACSC: Heart failure	1.2	1.2	0.060	0.094	1.2	0.050	0.135	1.3	0.170	0.000
ACO-11	Percent of PCPs that get EHR incentive payment	80.5	65.4	-18.790	0.000	75.7	-6.750	0.045	77.4	-5.130	0.139
ACO-12	Medication reconciliation	91.7	93.4	2.370	0.352	91.7	0.000	1.000	90.9	-0.960	0.685
ACO-13	Screening for fall risk	44.7	44.7	0.050	0.992	42.9	-2.170	0.632	38.1	-8.130	0.075
ACO-14	Flu vaccination	58.2	53.5	-5.400	0.014	55.7	-3.180	0.160	52.4	-6.620	0.003
ACO-15	Pneumonia vaccination	56.8	49.2	-8.490	0.033	49.5	-7.390	0.064	45.3	-13.490	0.000
ACO-16	BMI screening and follow-up	67.9	69.7	2.000	0.512	65.0	-3.950	0.198	67.7	-1.600	0.614
ACO-17	Tobacco screening and intervention	91.3	89.2	-2.490	0.061	89.2	-2.770	0.038	88.1	-3.620	0.008
ACO-18	Depression screening and follow-up	36.8	37.3	0.500	0.925	32.9	-6.010	0.256	30.4	-8.700	0.098
ACO-19	Colorectal cancer screening	57.7	48.2	-10.050	0.001	51.2	-7.300	0.006	54.2	-3.920	0.138
ACO-20	Breast cancer screening	63.0	57.2	-6.980	0.005	57.8	-5.250	0.038	56.7	-7.690	0.001

ACO-21	HTN screening and follow-up	59.3	65.8	7.650	0.137	60.7	1.970	0.695	56.5	-4.690	0.354
ACO D	Diabetes Composite	26.3	20.2	-7.050	0.000	21.2	-6.280	0.000	20.8	-6.570	0.000
ACO-22	Diabetes: HTN control (22-26=all or nothing composite)	71.7	67.1	-5.810	0.000	67.6	-4.820	0.000	67.5	-5.090	0.000
ACO-23	Diabetes: LDL control	58.1	52.8	-5.740	0.000	54.5	-4.050	0.011	50.7	-8.270	0.000
ACO-24	Diabetes: A1c control	71.1	68.8	-2.850	0.028	67.9	-4.120	0.000	65.9	-6.500	0.000
ACO-25	Diabetes: daily aspirin or antiplatelet if vascular disease	80.6	73.3	-8.850	0.000	76.2	-5.710	0.002	76.4	-4.620	0.006
ACO-26	Diabetes: tobacco non-use	84.5	83.7	-1.040	0.592	86.3	2.060	0.212	82.9	-1.830	0.287
ACO-27	Diabetes: A1c poor control	17.8	22.1	5.830	0.000	21.8	5.140	0.000	22.3	6.080	0.000
ACO-28	Hypertension: control	69.4	67.3	-2.430	0.034	66.5	-3.600	0.002	64.3	-6.000	0.000
ACO-29	Ischemic vascular disease: lipid panel and LDL control	58.8	54.9	-4.510	0.007	54.5	-4.740	0.003	55.3	-4.460	0.005
ACO-30	Ischemic vascular disease: aspirin / antithrombotic	85.6	82.2	-3.790	0.006	86.3	0.950	0.522	84.0	-1.740	0.259
ACO-31	Heart failure: beta-blocker for LVSD	87.9	85.1	-3.180	0.041	88.9	1.190	0.488	88.0	0.140	0.930
ACO C	CAD composite	69.4	64.8	-5.100	0.019	67.8	-2.550	0.268	65.1	-5.290	0.013
ACO-32	CAD: lipid control	77.0	75.2	-2.230	0.222	75.2	-2.370	0.185	73.2	-5.340	0.007
ACO-33	CAD: ACE or ARB for diabetes or LVSD	77.1	75.5	-1.710	0.306	77.7	0.660	0.699	76.9	-0.170	0.921

B. Hispanic, Low-income ZCTA, Rural

Quality Measure			**Pct Hispanic**			**ZCTA Income**			**Pct Rural (Non-MSA)**		
			Median Performance, Top Quintile	**Median Regression**		**Median Performance, Top Quintile**	**Median Regression**		**Median Performance, Top Quintile**	**Median Regression**	
	Description	**Median**		**Difference (Beta)**	**P > |t|**		**Difference (Beta)**	**P > |t|**		**Difference (Beta)**	**P > |t|**
ACO-1	CAHPS: Timely care, appts, info	80.6	78.3	-2.750	0.000	78.8	-1.970	0.003	81.2	0.770	0.196
ACO-2	CAHPS: Provider communication	92.7	92.0	-0.750	0.005	92.6	-0.120	0.687	92.8	0.280	0.269
ACO-3	CAHPS: Patient rating of provider	91.9	90.8	-1.190	0.000	91.6	-0.360	0.234	91.7	-0.190	0.503
ACO-4	CAHPS: Access to specialists	84.1	83.5	-0.850	0.025	83.9	-0.350	0.354	83.4	-0.910	0.018

ACO-5	CAHPS: Health promotion / education	58.2	59.3	1.180	0.072	56.3	-2.260	0.000	56.5	-2.220	0.000
ACO-6	CAHPS: Shared decision making	74.7	74.5	-0.140	0.745	74.6	-0.100	0.810	74.5	-0.260	0.518
ACO-7	CAHPS: Health status / fxl status	71.3	69.7	-2.070	0.000	69.6	-1.960	0.000	71.8	0.550	0.195
ACO-8	Risk-standardized all-condition readmission	15.1	15.3	0.200	0.082	15.3	0.210	0.069	14.9	-0.190	0.086
ACO-9	ACSC: COPD	1.0	1.1	0.090	0.197	1.0	0.020	0.779	1.0	-0.030	0.653
ACO-10	ACSC: Heart failure	1.2	1.2	0.000	1.000	1.2	0.030	0.382	1.1	-0.060	0.069
ACO-11	Percent of PCPs that get EHR incentive payment	80.5	63.8	-20.380	0.000	78.2	-4.300	0.180	84.4	3.870	0.235
ACO-12	Medication reconciliation	91.7	93.6	2.550	0.264	92.4	0.470	0.844	91.9	0.250	0.916
ACO-13	Screening for fall risk	44.7	38.5	-5.130	0.283	41.4	-3.390	0.494	48.3	4.480	0.344
ACO-14	Flu vaccination	58.2	52.0	-7.850	0.001	55.1	-3.570	0.133	63.6	5.790	0.014
ACO-15	Pneumonia vaccination	56.8	44.7	-14.560	0.000	51.4	-6.350	0.091	62.2	6.080	0.103
ACO-16	BMI screening and follow-up	67.9	72.0	4.490	0.141	72.0	3.960	0.183	69.6	1.600	0.601
ACO-17	Tobacco screening and intervention	91.3	87.5	-4.410	0.001	89.5	-2.200	0.103	91.3	0.100	0.941
ACO-18	Depression screening and follow-up	36.8	30.9	-6.930	0.179	36.1	-1.020	0.847	47.9	11.750	0.020
ACO-19	Colorectal cancer screening	57.7	47.1	-11.730	0.000	53.0	-4.480	0.086	62.0	3.810	0.145
ACO-20	Breast cancer screening	63.0	55.3	-9.840	0.000	59.3	-4.470	0.080	66.3	4.810	0.040
ACO-21	HTN screening and follow-up	59.3	69.9	12.600	0.009	59.5	1.150	0.819	60.9	3.100	0.538
ACO D	Diabetes Composite	26.3	21.7	-5.370	0.003	22.0	-5.440	0.003	23.8	-2.920	0.088
ACO-22	Diabetes: HTN control (22-26=all or nothing composite)	71.7	65.6	-7.400	0.000	70.2	-1.840	0.139	71.9	0.130	0.917
ACO-23	Diabetes: LDL control	58.1	53.8	-4.820	0.002	55.1	-3.650	0.014	56.4	-2.010	0.159
ACO-24	Diabetes: A1c control	71.1	68.1	-3.930	0.001	67.9	-4.240	0.001	71.1	0.020	0.987
ACO-25	Diabetes: daily aspirin or antiplatelet if vascular disease	80.6	76.9	-3.880	0.053	77.5	-3.720	0.023	79.2	-1.750	0.292
ACO-26	Diabetes: tobacco non-use	84.5	74.7	-11.070	0.000	82.5	-2.530	0.152	86.2	2.080	0.205
ACO-27	Diabetes: A1c poor control	17.8	24.4	8.530	0.000	19.9	2.510	0.104	15.7	-2.210	0.159
ACO-28	Hypertension: control	69.4	66.7	-3.110	0.005	66.4	-3.760	0.001	68.9	-0.540	0.645
ACO-29	Ischemic vascular disease: lipid panel and LDL control	58.8	54.9	-4.910	0.003	57.5	-1.730	0.260	57.7	-1.530	0.342
ACO-30	Ischemic vascular disease: aspirin / antithrombotic	85.6	79.5	-6.760	0.000	84.1	-1.670	0.265	88.0	3.480	0.021

ACO-31	Heart failure: beta-blocker for LVSD	87.9	88.6	0.840	0.607	87.1	-0.980	0.573	87.8	-0.140	0.934
ACO C	CAD composite	69.4	68.6	-1.190	0.629	66.7	-3.370	0.130	68.3	-1.320	0.561
ACO-32	CAD: lipid control	77.0	75.4	-1.610	0.419	75.3	-2.070	0.282	76.5	-0.850	0.660
ACO-33	CAD: ACE or ARB for diabetes or LVSD	77.1	79.5	2.460	0.142	76.0	-1.660	0.321	77.8	0.370	0.831

Appendix Chapter 10: The Physician Value-Based Payment Modifier

Additional information about cost and quality measures

CMS calculated practices' cost performance with 5 cost measures (total per capita costs of care, and four condition-specific per capita costs of care), based on a practice's attributed beneficiaries. Beneficiaries were attributed to practices based on a plurality of primary care E&M visits, similar to the algorithm used for the Medicare Shared Savings Program.

Each of the 5 cost measures is a price-standardized cost ratio comparing actual-to-expected costs, where expected costs incorporated dual status as well as medical complexity. The measure score for each of the 5 cost measures is calculated using the following steps:

1. Risk adjustment. Regress each beneficiary's price-standardized cost against the beneficiary HCC risk score (and squared term) and ESRD status. Obtain the beneficiary's expected cost from the regression.

2. At practice level, calculate risk-adjusted per-capita cost as national observed per-capita cost * actual-to-expected cost ratio of the practice.

3. For practices with 100+ EPs, calculate the individual cost measure score by standardizing the risk-adjusted costs among all practices with 100+ EPs (z-score).

For quality measurement, practices could choose from several options. There were a set of three mandatory measures (all-cause readmissions, acute ambulatory care sensitive conditions or ASCSs, and chronic ACSCs) based on a practice's attributed patients. Practices were also required to report on additional quality measures through the: 1) Group Practice Reporting Option (GPRO) Web (22 measures for 411 consecutive beneficiaries), 2) GPRO Registry (minimum of 3 measures for a minimum of 80% of Medicare Part B FFS patients), or 3) administrative claims (14 measures). A large group practice's score on an individual quality measure was defined as the number of standard deviations from the peer group mean, which is the previous year's case-weighted, national mean.

The final value modifier was calculated by rolling measure performance up to the 2 cost domains (total per capita costs and condition-specific per capita costs) and 6 quality domains (care coordination; clinical process/effectiveness; patient safety; population/public health; efficient use of health care resources; and patient and family engagement). These domains were then rolled up to a quality (and cost) composite. Each domain score was the average of a practice's individual measure scores in that domain, as long as a practice had at least one measure in that domain. In addition, only measures with at least 20 eligible cases were included when calculating quality domains. Similarly the composite score was an average of domain scores. The quality and cost composite scores were then standardized against peer groups. For VM-eligible practices, their peer group is all practices with 100+ EPs.

All VM-eligible practices received a value modifier. VM-eligible practices that met the minimum reporting requirement and elected "quality tiering" received a value modifier based on their performance on cost and quality. VM-eligible practices that met the minimum reporting requirement but did not elect "quality tiering" received a neutral adjustment. VM-eligible practices that failed to meet the minimum reporting requirement received a downward adjustment. Additional detail about the quality and cost measures is included in the Detailed Methodology for 2015 Value-based Payment Modifier.

General methodology

1. Introduction

The main purpose of this section is to describe and document the analysis done to explore the relationship between beneficiary and provider social risk factors and the current Physician Value-based Modifier (VM) Program.

This general methodology appendix includes the following sections:

- Section 1: Introduction
- Section 2: Definition of social risk factors
- Section 3: Regression models with social risk factor methodology as the primary predictor
- Section 4: Simulation methodologies

It does not cover:

1) individual measure building methodologies,

2) calculation of domain and composite scores, or

3) calculation of VM adjustment categories,

as these procedures are defined by CMS and are publicly documented. Throughout the analysis, we have referred to the following links as official methodologies:

Technical program overview:

- Detailed methodology for 2015 value-based payment modifier (https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeedbackProgram/Downloads/2013-Detailed-Methodology.pdf)

Claim-based measure building:

- 2014 ACSC measure specifications (https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeedbackProgram/Downloads/2014-ACSC-MIF.pdf)
- 2014 readmission measure specifications (https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeedbackProgram/Downloads/2014-ACR-MIF.pdf)
- 2014 per-capita cost measure specifications (https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeedbackProgram/Downloads/2014-MIF-TPCC.pdf) (although this report does not include specialty-adjustment as it is based on 2013 performance data)

2. Definition of social risk factors

2.1 Beneficiary social risk factors

Any beneficiary attributed to a practice, as indicated by the beneficiary-alignment file, was assigned a set of indicator variables based on beneficiary social risk factors. Table 1 displays the data sources and definitions of these social risk factors used throughout the analysis. These variables are referred as "beneficiary social risk factors" in the rest of this chapter.

Table 1. Beneficiary social risk factors

Variables	Descriptions	Data source
Dual*	Indicator of the beneficiary's dual eligibility in the first month of CY 2013 (both partial and full dual)	Enrollment Database
Low ZCTA income	Indicator of whether the beneficiary's residence as on 1/1/2013 is in a below-national-median zip code tabulation (ZCTA) area	Enrollment Database, 5-year ACS estimates, UDS Mapper Zip to ZCTA crosswalk (2014)
Black	Indicator of the beneficiary being black according to the Research Triangle Institute (RTI) race code	Master Beneficiary Summary File
Hispanic	Indicator of the beneficiary being Hispanic according to RTI race	Master Beneficiary Summary File
Rural	Indicator of whether the beneficiary's residence as on 1/1/2013 is in a non-core-based statistical area (CBSA) county	Enrollment Database
Disabled	Indicator of the beneficiary's original entitlement reason for Medicare being disability	Enrollment Database
High complexity	Indicator of whether the beneficiary has a Hierarchical Conditions Category (HCC) risk score above the 75th percentile among all Medicare fee-for-service (FFS) beneficiaries	Risk Adjustment Processing System (RAPS)
High income	Indicator of whether the beneficiary pays an additional Part B income-related monthly adjustment premium on 1/1/2013	Enrollment Database

* The dual eligibility covers both "full-dual" and "partial-dual", which includes the categories in red: 00 = Not Medicare enrolled for the month; 01 = QMB only (Qualified Medicare Beneficiaries; Medicaid pays Part A & B premiums); 02 = QMB and Medicaid coverage including RX (aka QMB Plus; full Medicaid); 03

= SLMB only (Specified Low-Income Medicare Beneficiaries; Medicaid pays Part B premium); 04 = SLMB and Medicaid coverage including RX (aka SLMB Plus; full Medicaid); 05 = QDWI (Qualified Disabled and Working Individuals; Medicaid purchases Part A benefits, but no Medicaid benefits); 06 = Qualifying Individuals (QI; Medicaid pays Part B premium, but no Medicaid benefits); 08 = Other Dual Eligibles (Non-QMB, SLMB, QWDI, or QI) w/Medicaid coverage including RX; 09 = Other Dual Eligibles but without Medicaid coverage; 99 = Unknown NA = Non-Medicaid XX = Enrolled in Medicare A and/or B, but no MIIR* record for the month

More detail is available at: CCW Technical Guidance - Options for Determining Which CMS Medicare Beneficiaries are Dually Eligible for Medicare and Medicaid Benefits: http://www.ccwdata.org/cs/groups/public/documents/training/ccw_dualeligibles_techguide.pdf (page 3)

2.2 Practice social risk factors

Any practice on the analytic file that has at least 1 attributed beneficiary was assigned a "practice social risk factor" according to the proportion of its attributed beneficiaries with that social risk factors. The following procedure was applied to determine practice social risk factors:

1. For each practice with at least 1 beneficiary, calculate the proportion of beneficiaries with the social risk factor.
2. Use this proportion to rank all VM eligible practices with at least 1 beneficiary.
3. Flag the practice social risk factor as 1 if the practice is in the top quintile of proportion of attributed beneficiaries with the social risk factor. The steps above were applied for all the practice SES factors, except for high complexity.

The following procedures were applied to define high-complexity practices.

1. For each practice, calculate the average risk score among all of its attributed beneficiaries.
2. If the calculated average is higher than the 75^{th} percentile risk score value among all Medicare fee-for-service beneficiaries (not just those attributed to practices in the VM Program), flag the practice as a high-complexity practice.

3. Regression models with social risk factor methodology as the primary predictor

3.1 Hospital-wide, all-cause, unplanned readmissions measure

The readmission regression analyses are run on 5 cohort-specific index-stay level files separately, with a 0 or 1 outcome for each index-stay, indicating whether or not the index stay was followed by an unplanned readmission within 30 days. Logistic link functions are applied to model the 0/1 outcomes, therefore all the coefficient estimates are reported as odds ratios.

The analyses were done in 3 parts, in order to explore the impact of social risk factors at different levels. The regressions included the following covariates:

Part 1. Beneficiary social risk factor alone, with/ without CMS-defined risk adjustment variables

Part 2. Practice social risk factor alone, with/ without CMS-defined risk adjustment variables

Part 3. Beneficiary and practice social risk factors combined, with/without CMS defined risk adjustment variables.

For each of the 3 analyses, a Random Effects (RE) model was constructed, with practice-level random intercepts, in order to evaluate the within-practice effects of each social risk factor. The RE model also reflects the risk-adjustment methodology applied by CMS for the hospital-wide, all-cause, unplanned rate.

3.2 Acute and chronic ambulatory care sensitive condition (ACSC) measures

The ACSC measure regressions explore the relationship between each ACSC individual observed measure outcome and the beneficiary/practice social risk factors. The regression analyses also report odds ratios for each social risk factor, with or without CMS risk-adjustment variables included. Following the approach taken by Mathematica Policy Research (MPR), [1] the regression file was a beneficiary-discharge level file, built for each ACSC condition separately.

The ACSC regression analyses were run for each of the individual ACSC measures separately. Logistic link functions are applied to model the 0/1 outcomes; therefore, all the coefficient estimates are reported as odds ratios. Each observation is weighted by the weight calculated in the previous steps.

The analyses are split into 3 parts, exploring the impact of social risk factors at different levels. The regressions include the following covariates:

Part 1. Beneficiary social risk factor alone, with/ without CMS defined risk adjustment variables

Part 2. Practice social risk factor alone, with/ without CMS defined risk adjustment variables

Part 3. Beneficiary and practice social risk factors combined, with/without CMS defined risk adjustment variables.

For each of the 3 analyses, a Random Effects (RE) model was applied, allowing practice-level random intercepts, in order to evaluate the within-practice effects of each social risk factor.

3.3 Total and condition-specific cost measures

Regression analyses for the cost measure seek to explore the relationship between beneficiary / practice social risk factors, and all-condition or condition-specific standardized, risk-adjusted per-capita cost.

The table below shows steps to run the regression analyses for the cost measures. The steps are applied to all condition cost, and each condition-specific cost separately.

[1] Mathematica Policy Research. Final Report: Selected Functional Specifications for the 2013 Quality and Resource Use Reports. May 11, 2016.

Steps	Details	Equations/calculations	Level	Remarks	Question
1	run regression	std-cost = risk-score + risk-score ^2 + ESRD	Beneficiary level	CMS risk adjustment	
2	run regression	std-cost = beneficiary-SES + risk-score + risk-score ^2 + ESRD	Beneficiary level	SES + CMS risk adjustment	Part 1
3	roll up to TIN level, calculate CMS-risk-adj-cost	TIN's CMS-risk-adj-cost = national average standardized cost * TIN's observed total cost/TIN's predicted total cost (from regression 1)	Bene-to-practice		
4	roll up to TIN level, calculate SES-risk-adj-cost	TIN's SES-risk-adj-cost = national average standardized cost * TIN's observed total cost/TIN's predicted total cost (from regression 2)	Bene-to-practice		
5	run regression	CMS-risk-adj-cost = practice-SES	Practice level		Part 2
6	run regression	SES-risk-adj-cost = practice-SES	Practice level		Part 3

Using the notations from the table above, the cost measure regression analyses are run at separate levels. The first-level (beneficiary-level) regressions (step 1 and step 2) are run using a beneficiary-level file that includes all Medicare fee-for-service beneficiaries attributed to all practices nationwide (regardless of whether or not they are in the VM Program). Two models were run, the first (step 1) regressing beneficiary social risk factor on cost (unadjusted analyses), and the second (step 2) regressing beneficiary social risk plus CMS risk-adjustment variables on cost (adjusted analyses),

For first-level (beneficiary-level) regression analyses, a Random Effects (RE) model was applied, allowing practice-level random intercepts, in order to evaluate the within-practice effects of each SES factor. The RE model also reflects the methodology applied by CMS in the HWR program risk adjustment.

Before second-level (practice-level) regressions (step 5 and step 6) were run, a risk-adjusted cost for each TIN was calculated, based on regression predictions from the patient-level models:

TIN's Risk-adjusted cost = national average standardized cost * TIN's observed total cost/TIN's predicted total cost

Two risk-adjusted costs were calculated for each TIN: the CMS-risk-adjusted, and the SES+CMS-adjusted. Using this constructed TIN-level file, second-level (practice-level) OLS regression models that include high-social risk practice as the primary predictor are run with the following outcomes:

1. the CMS-risk-adjusted cost as the dependent variable
2. the SES+CMS-risk-adjusted cost as the dependent variable

The second-level regressions are run on 3 sub-groups of practices: all practices, VM eligible practices only, and VM eligible practices that also met minimum requirements. Within each sub-group, the regressions are run with each practice weighted equally, and weighted by number of attributed beneficiaries that have the corresponding cost. For each of the second-level regressions, p-values are calculated based on robust standard errors, in order to account for the fact that both population size

(number of practices) and variance of average costs are different between high-SES group and the reference (none high-SES) group.

4. Simulation methodologies

All of the simulation analyses follow the roll-up process from individual measure outcomes to quality/cost composite scores that is described in the Quality and Resource Use Report (QRUR) documentation. The simulations modify a part of the roll-up process or a part of measure-level risk-adjustment methodology, to add social risk factors into the final quality/cost composite scores.

All the tables for the simulation analyses are based on only a sub-group of practices – VM eligible practices that met the minimum reporting requirement. If the TIN met the minimum reporting requirement, but didn't have any attributed beneficiaries, the TIN would have either a missing cost and/or quality composite and receive a neutral adjustment. After simulations, the adjustment categories were based only on the cost and quality composite scores (i.e., no automatic neutral adjustment for not selecting quality tiering was applied).

4.1 Direct social risk factor adjustment for readmission and ACSC measures

This simulation is applied to readmission and ACSC measures directly at the measure level. The beneficiary dual/high complexity factors are added to CMS' existing risk-adjustment models, producing new risk-standardized readmission rates (RSRRs) and new risk-adjusted ACSC measure outcomes. The new measure outcomes are rolled-up to final VM adjustment categories following the same methodology as in the QRUR program. Of note, if direct risk-adjustment of individual measures for social risk factors is to be explored, an approach that separates patient and practice effects in the measure's risk-adjustment model would need to be developed. The same caveat applies to sections 4.2 and 4.3 below as well.

4.2 Direct HCC risk score adjustment for ACSC measures

This simulation is applied to ACSC measures directly at the measure level. The beneficiary's HCC risk score is added to CMS' existing risk-adjustment models, producing new risk-adjusted ACSC measure outcomes. The new measure outcomes are rolled-up to final VM adjustment categories following the same methodology as in the QRUR program.

4.3 Direct social risk factor adjustment for per-capita cost measures

This simulation is applied to all-condition and condition-specific cost measures directly at the measure level. The beneficiary dual/high complexity factors are added to CMS' existing risk-adjustment to generate simulated expected costs. New risk-adjusted costs were calculated for each TIN based on the new expected costs, and new cost measure scores were calculated accordingly. The new measure scores are rolled-up to final VM adjustment categories following the same methodology as in the QRUR program.

The beneficiary-level file for cost measure simulation is built from raw claims. Before applying any simulations, we rolled up the claim-based beneficiary-level cost file into TIN-level cost performance

categories following the current program. Results using VM Program-level data were then compared to results from the claims-based model (Table).

Table. Counts of VM-eligible practices that meet minimum requirement within each cost performance category, comparing results from VM program-level data vs. claims-based model results

	VM Program-level data	Claim-based models
Low cost	21	18
Average cost	651	652
High cost	34	36

Very few practices were assigned to a different cost category based on the constructed claim-based costs. For this reason, we compared our results from the claims-based cost simulation models (Table 10.18 in the chapter) to a baseline based on VM Program-level data (Table 10.13 in the chapter).

4.4 Provide a bonus for high performance for practices that serve a high proportion of high social risk patients

The bonus simulation was applied to final VM adjustment category / quality composite score. Two types of bonus options were explored, based on whether the practice was a high social risk practice, and the proportion of beneficiaries with the social risk factor within the practice.

3. Direct bonus to VM adjustment category
   In this simulation, +1.0x was added to the value modifier for high dual/disabled/complexity practices, if the practice already qualified for an upward adjustment. No analyses were performed for this simulation.

4. Addition to quality composite score before standardization
   1) Calculate the standard deviation (SD) of the non-standardized quality composite score among all practices with 100+ EPs (the calculated SD is referred to as "SD" in the next step).
   2) For each practice with 100+ EPs, calculate the newly simulated non-standardized quality composite score as the original composite score + 0.2*SD*proportion of dual/disabled/high complexity beneficiaries.
   3) Standardize the newly simulated quality composite score among all practices with 100+ EPs, and construct final VM adjustment categories based on the newly simulated standardized quality composite score, and the original standardized cost composite score.

Types of providers in the non-physician and other categories

Non-physician	Certified Nurse Midwife
	Registered Dietician/Nutrition Professional
	Occupational Therapist (Independently Practicing)
	Certified Clinical Nurse Specialist
	Speech Language Pathologists
	Nurse Practitioner
	Clinical Psychologist (Billing Independently)
	Anesthesiologist Assistant
	Certified Registered Nurse Anesthesiologist
	Physician Assistant
	Audiologist (Billing Independently)
	Chiropractor, Licensed
	Licensed Clinical Social Worker
	Physical Therapist (Independently Practicing)
Other	Diagnostic Radiology
	Emergency Medicine
	Anesthesiology
	Single or Multispecialty Clinic or Group Practice
	Interventional Radiology
	Optometrist

Note: In Appendices 9.4 (readmissions) and 9.5 (ACSCs), the models for Q1, Q2, and Q3 are as follows.

Q1: Random effects patient-level model with indicator for high social risk patient

Q2: Random effects patient-level model with indicator for high social risk practice

Q3: Random effects patient-level model with indicator for high social risk patient and high social risk practice.

Appendix 9.3a. Odds of readmission for high social risk patients, part 1

Beneficiary SES variables & Practice high SES	Surgery/Gynecology						
	Without risk-adjustment			Risk-adjusted			
	Raw rate = (SES)	11.64% (Ref.)	Raw rate ratio	RE - Q1 & Q2 Odds	P-value	RE - Q3 Odds	P-value
All VM eligible Practices							
Bene Dual	16.32%	10.20%	1.600	1.195	<.0001	1.177	<.0001
Practice High Dual	18.12%	10.56%	1.716	1.287	<.0001	1.230	<.0001
Bene Low ZCTA income	11.60%	10.37%	1.119	1.045	0.001	1.042	0.002
Practice Low ZCTA income	11.40%	10.87%	1.049	1.044	0.077	1.025	0.317
Bene Black	14.72%	10.67%	1.380	1.090	0.000	1.064	0.010
Practice High Black	13.47%	10.62%	1.268	1.146	<.0001	1.130	<.0001
Bene Hispanic	12.40%	10.89%	1.138	0.997	0.931	0.978	0.547
Practice High Hispanic	12.77%	10.73%	1.190	1.080	0.004	1.083	0.003
Bene Rural	10.80%	10.96%	0.985	1.002	0.921	0.999	0.969
Practice High Rural	10.75%	10.98%	0.979	1.007	0.751	1.007	0.762
Bene Disabled	14.42%	10.46%	1.379	1.212	<.0001	1.210	<.0001
Practice High Disabled	13.84%	10.86%	1.274	1.129	0.005	1.111	0.015
Bene High complexity	15.82%	7.56%	2.092	1.345	<.0001	1.340	<.0001
Practice High complexity	15.07%	10.21%	1.476	1.222	<.0001	1.207	<.0001
Bene High income	8.71%	11.26%	0.773	0.889	<.0001	0.895	<.0001
Practice High income	9.87%	11.29%	0.874	0.918	<.0001	0.929	0.001

Appendix 9.3b. Odds of readmission for high social risk patients, part 2

Beneficiary SES variables & Practice high SES	Medicine						
	Without risk-adjustment			Risk-adjusted			
	Raw rate = (SES)	17.10% (Ref.)	Raw rate ratio	RE - Q1 & Q2 Odds	P-value	RE - Q3 Odds	P-value
All VM eligible Practices							
Bene Dual	19.42%	15.65%	1.241	1.109	<.0001	1.103	<.0001
Practice High Dual	20.74%	16.12%	1.287	1.137	<.0001	1.103	<.0001
Bene Low ZCTA income	17.04%	15.98%	1.066	1.033	0.000	1.034	0.000
Practice Low ZCTA income	16.75%	16.47%	1.017	1.008	0.677	0.994	0.757
Bene Black	19.23%	16.17%	1.189	1.051	0.000	1.034	0.019
Practice High Black	18.90%	16.09%	1.175	1.127	<.0001	1.116	<.0001
Bene Hispanic	18.20%	16.44%	1.107	1.013	0.549	1.004	0.873
Practice High Hispanic	18.09%	16.28%	1.111	1.056	0.008	1.055	0.010
Bene Rural	16.77%	16.45%	1.019	1.026	0.046	1.039	0.007
Practice High Rural	16.13%	16.59%	0.972	0.977	0.187	0.957	0.024
Bene Disabled	19.63%	15.94%	1.231	1.085	<.0001	1.084	<.0001
Practice High Disabled	18.29%	16.44%	1.113	1.075	0.013	1.067	0.025
Bene High complexity	19.11%	11.77%	1.624	1.224	<.0001	1.221	<.0001
Practice High complexity	19.84%	15.62%	1.270	1.183	<.0001	1.172	<.0001
Bene High income	14.70%	16.70%	0.881	0.943	<.0001	0.945	0.000
Practice High income	15.78%	16.72%	0.944	0.963	0.035	0.969	0.071

Appendix 9.3c. Odds of readmission for high social risk patients, part 3

Beneficiary SES variables & Practice high SES	Cardiorespiratory						
	Without risk-adjustment			Risk-adjusted			
	Raw rate = (SES)	19.51% (Ref.)	Raw rate ratio	RE - Q1 & Q2 Odds	P-value	RE - Q3 Odds	P-value
All VM eligible Practices							
Bene Dual	22.67%	17.49%	1.296	1.181	<.0001	1.169	<.0001
Practice High Dual	24.43%	18.28%	1.336	1.236	<.0001	1.178	<.0001
Bene Low ZCTA income	19.45%	17.91%	1.086	1.062	<.0001	1.059	<.0001
Practice Low ZCTA income	19.32%	18.61%	1.038	1.049	0.053	1.025	0.337
Bene Black	22.14%	18.34%	1.207	1.119	<.0001	1.105	<.0001
Practice High Black	20.83%	18.39%	1.132	1.101	0.000	1.068	0.014
Bene Hispanic	20.69%	18.65%	1.109	1.066	0.073	1.048	0.195
Practice High Hispanic	20.36%	18.52%	1.100	1.082	0.005	1.074	0.012
Bene Rural	18.51%	18.76%	0.986	0.997	0.874	0.996	0.829
Practice High Rural	18.50%	18.78%	0.985	1.002	0.931	1.004	0.865
Bene Disabled	22.27%	17.96%	1.240	1.117	<.0001	1.116	<.0001
Practice High Disabled	21.47%	18.61%	1.154	1.135	0.002	1.127	0.003
Bene High complexity	20.87%	12.70%	1.644	1.255	<.0001	1.252	<.0001
Practice High complexity	22.60%	17.84%	1.267	1.201	<.0001	1.194	<.0001
Bene High income	15.22%	19.01%	0.800	0.861	<.0001	0.867	<.0001
Practice High income	17.20%	19.11%	0.900	0.913	0.000	0.924	0.001

Appendix 9.3d. Odds of readmission for high social risk patients, part 4

Beneficiary SES variables & Practice high SES	Cardiovascular						
	Without risk-adjustment			Risk-adjusted			
	Raw rate = (SES)	14.57% (Ref.)	Raw rate ratio	RE - Q1 & Q2 Odds	P-value	RE - Q3 Odds	P-value
All VM eligible Practices							
Bene Dual	17.40%	13.00%	1.338	1.163	<.0001	1.144	<.0001
Practice High Dual	18.87%	13.43%	1.405	1.244	<.0001	1.193	<.0001
Bene Low ZCTA income	14.48%	13.05%	1.110	1.087	<.0001	1.090	<.0001
Practice Low ZCTA income	14.16%	13.68%	1.035	1.019	0.584	0.982	0.602
Bene Black	16.82%	13.44%	1.251	1.131	0.000	1.092	0.010
Practice High Black	15.96%	13.41%	1.190	1.173	<.0001	1.145	0.000
Bene Hispanic	16.03%	13.68%	1.172	1.103	0.074	1.086	0.138
Practice High Hispanic	15.06%	13.59%	1.108	1.061	0.108	1.049	0.206
Bene Rural	13.85%	13.72%	1.009	1.005	0.849	1.044	0.161
Practice High Rural	13.14%	13.90%	0.945	0.935	0.026	0.914	0.009
Bene Disabled	17.04%	13.26%	1.285	1.211	<.0001	1.210	<.0001
Practice High Disabled	15.48%	13.69%	1.131	1.076	0.209	1.057	0.345
Bene High complexity	16.82%	9.76%	1.724	1.242	<.0001	1.237	<.0001
Practice High complexity	17.17%	13.09%	1.312	1.193	<.0001	1.184	<.0001
Bene High income	11.99%	13.95%	0.859	0.941	0.069	0.941	0.070
Practice High income	13.27%	13.89%	0.955	0.995	0.872	1.001	0.968

Appendix 9.3e. Odds of readmission for high social risk patients, part 5

Beneficiary SES variables & Practice high SES	Neurology						
	Without risk-adjustment			Risk-adjusted			
	Raw rate = (SES)	13.39% (Ref.)	Raw rate ratio	RE - Q1 & Q2 Odds	P-value	RE - Q3 Odds	P-value
All VM eligible Practices							
Bene Dual	14.83%	11.60%	1.279	1.137	<.0001	1.118	0.000
Practice High Dual	16.82%	11.87%	1.417	1.279	<.0001	1.241	<.0001
Bene Low ZCTA income	12.64%	11.83%	1.069	1.049	0.055	1.050	0.056
Practice Low ZCTA income	12.26%	12.21%	1.004	1.012	0.774	0.991	0.841
Bene Black	15.28%	11.84%	1.291	1.191	<.0001	1.170	<.0001
Practice High Black	14.03%	11.94%	1.175	1.126	0.004	1.076	0.085
Bene Hispanic	13.54%	12.17%	1.112	1.041	0.540	1.000	0.995
Practice High Hispanic	14.22%	11.97%	1.188	1.151	0.001	1.151	0.001
Bene Rural	11.58%	12.33%	0.939	0.937	0.064	0.981	0.636
Practice High Rural	11.14%	12.48%	0.893	0.891	0.002	0.899	0.011
Bene Disabled	14.59%	11.88%	1.228	1.068	0.070	1.067	0.078
Practice High Disabled	13.63%	12.17%	1.120	1.095	0.205	1.090	0.229
Bene High complexity	14.42%	9.62%	1.499	1.144	<.0001	1.138	<.0001
Practice High complexity	15.33%	11.52%	1.331	1.217	<.0001	1.208	<.0001
Bene High income	10.92%	12.37%	0.883	0.925	0.054	0.923	0.050
Practice High income	11.95%	12.30%	0.972	1.008	0.816	1.016	0.650

Appendix 9.4a. Acute ACSCs, part 1

Beneficiary SES variables & Practice high SES	Acute Composite							
	Without Risk Adjustment				Risk-adjusted			
	RE Q1 & Q2		RE Q3		RE Q1 & Q2		RE Q3	
	Odds	P-value	Odds	P-value	Odds	P-value	Odds	P-value
All VM 100-plus Practices								
Bene Dual	1.734	<.0001	1.736	<.0001	2.092	<.0001	2.092	<.0001
Practice High Dual	1.150	0.009	0.901	0.045	1.277	<.0001	0.997	0.954
Bene Low ZCTA income	1.161	<.0001	1.159	<.0001	1.177	<.0001	1.175	<.0001
Practice Low ZCTA income	1.252	<.0001	1.173	0.001	1.295	<.0001	1.207	<.0001
Bene Black	0.941	<.0001	0.940	<.0001	1.045	0.000	1.043	0.000
Practice High Black	1.044	0.391	1.065	0.205	1.129	0.007	1.114	0.017
Bene Hispanic	0.977	0.181	0.978	0.208	1.088	<.0001	1.088	<.0001
Practice High Hispanic	0.934	0.179	0.937	0.206	0.995	0.921	0.980	0.678
Bene Rural	1.049	<.0001	1.044	<.0001	1.090	<.0001	1.086	<.0001
Practice High Rural	1.226	<.0001	1.197	0.000	1.215	<.0001	1.159	0.001
Bene Disabled	1.109	<.0001	1.110	<.0001	2.465	<.0001	2.465	<.0001
Practice High Disabled	0.903	0.084	0.869	0.017	1.093	0.117	1.010	0.849
Bene High complexity	4.735	<.0001	4.729	<.0001	3.887	<.0001	3.881	<.0001
Practice High complexity	1.796	<.0001	1.410	<.0001	1.766	<.0001	1.462	<.0001
Bene High income	0.697	<.0001	0.698	<.0001	0.671	<.0001	0.672	<.0001
Practice High income	0.711	<.0001	0.743	<.0001	0.704	<.0001	0.735	<.0001

Appendix 9.4b. Acute ACSCs, part 2

Beneficiary SES variables & Practice high SES	Bacterial Pneumonia							
	Without Risk Adjustment				Risk-adjusted			
	RE Q1 & Q2		RE Q3		RE Q1 & Q2		RE Q3	
	Odds	P-value	Odds	P-value	Odds	P-value	Odds	P-value
All VM 100-plus Practices								
Bene Dual	1.612	<.0001	1.616	<.0001	2.031	<.0001	2.032	<.0001
Practice High Dual	1.085	0.139	0.879	0.017	1.209	0.000	0.952	0.334
Bene Low ZCTA income	1.163	<.0001	1.158	<.0001	1.187	<.0001	1.180	<.0001
Practice Low ZCTA income	1.360	<.0001	1.275	<.0001	1.410	<.0001	1.312	<.0001
Bene Black	0.772	<.0001	0.773	<.0001	0.868	<.0001	0.867	<.0001
Practice High Black	0.903	0.042	0.979	0.675	0.984	0.737	1.027	0.585
Bene Hispanic	0.942	0.017	0.947	0.032	1.049	0.060	1.053	0.041
Practice High Hispanic	0.859	0.003	0.867	0.006	0.913	0.065	0.905	0.045
Bene Rural	1.133	<.0001	1.117	<.0001	1.166	<.0001	1.149	<.0001
Practice High Rural	1.422	<.0001	1.336	<.0001	1.409	<.0001	1.303	<.0001
Bene Disabled	1.134	<.0001	1.136	<.0001	2.485	<.0001	2.485	<.0001
Practice High Disabled	0.886	0.049	0.845	0.006	1.073	0.235	0.988	0.837
Bene High complexity	5.071	<.0001	5.064	<.0001	4.218	<.0001	4.211	<.0001
Practice High complexity	1.553	<.0001	1.213	<.0001	1.538	<.0001	1.265	<.0001
Bene High income	0.717	<.0001	0.720	<.0001	0.674	<.0001	0.677	<.0001
Practice High income	0.674	<.0001	0.701	<.0001	0.661	<.0001	0.690	<.0001

Appendix 9.4c. Acute ACSCs, part 3

Beneficiary SES variables & Practice high SES	Urinary Tract Infection							
	Without Risk Adjustment				Risk-adjusted			
	RE Q1 & Q2		RE Q3		RE Q1 & Q2		RE Q3	
	Odds	P-value	Odds	P-value	Odds	P-value	Odds	P-value
All VM 100-plus Practices								
Bene Dual	1.948	<.0001	1.949	<.0001	2.296	<.0001	2.292	<.0001
Practice High Dual	1.268	0.000	0.947	0.390	1.445	<.0001	1.093	0.111
Bene Low ZCTA income	1.142	<.0001	1.140	<.0001	1.162	<.0001	1.159	<.0001
Practice Low ZCTA income	1.156	0.013	1.091	0.133	1.216	0.000	1.140	0.013
Bene Black	1.026	0.165	1.023	0.222	1.166	<.0001	1.159	<.0001
Practice High Black	1.102	0.102	1.094	0.134	1.222	0.000	1.165	0.005
Bene Hispanic	1.045	0.125	1.044	0.136	1.204	<.0001	1.199	<.0001
Practice High Hispanic	1.037	0.550	1.029	0.638	1.123	0.039	1.089	0.130
Bene Rural	0.947	0.004	0.943	0.002	1.001	0.962	0.998	0.914
Practice High Rural	1.047	0.416	1.081	0.172	1.040	0.447	1.042	0.444
Bene Disabled	0.984	0.218	0.986	0.281	2.592	<.0001	2.592	<.0001
Practice High Disabled	0.838	0.018	0.843	0.021	1.078	0.279	0.994	0.926
Bene High complexity	4.740	<.0001	4.727	<.0001	3.675	<.0001	3.662	<.0001
Practice High complexity	1.885	<.0001	1.497	<.0001	1.850	<.0001	1.565	<.0001
Bene High income	0.665	<.0001	0.667	<.0001	0.653	<.0001	0.655	<.0001
Practice High income	0.785	<.0001	0.822	0.001	0.777	<.0001	0.812	<.0001

Appendix 9.4d. Acute ACSCs, part 4

Beneficiary SES variables & Practice high SES	Dehydration							
	Without Risk Adjustment				Risk-adjusted			
	RE Q1 & Q2		RE Q3		RE Q1 & Q2		RE Q3	
	Odds	P-value	Odds	P-value	Odds	P-value	Odds	P-value
All VM 100-plus Practices								
Bene Dual	1.660	<.0001	1.661	<.0001	1.796	<.0001	1.794	<.0001
Practice High Dual	1.229	0.000	0.987	0.818	1.243	0.000	1.027	0.630
Bene Low ZCTA income	1.194	<.0001	1.195	<.0001	1.182	<.0001	1.182	<.0001
Practice Low ZCTA income	1.062	0.227	0.983	0.738	1.078	0.120	1.004	0.930
Bene Black	1.242	<.0001	1.228	<.0001	1.295	<.0001	1.279	<.0001
Practice High Black	1.251	<.0001	1.164	0.003	1.285	<.0001	1.184	0.001
Bene Hispanic	0.945	0.148	0.940	0.114	0.994	0.884	0.987	0.740
Practice High Hispanic	1.057	0.296	1.068	0.218	1.081	0.128	1.083	0.121
Bene Rural	1.008	0.737	1.016	0.493	1.034	0.148	1.045	0.061
Practice High Rural	0.940	0.204	0.932	0.161	0.939	0.176	0.916	0.071
Bene Disabled	1.263	<.0001	1.263	<.0001	2.065	<.0001	2.063	<.0001
Practice High Disabled	1.073	0.282	0.987	0.846	1.140	0.042	1.071	0.278
Bene High complexity	3.657	<.0001	3.632	<.0001	3.215	<.0001	3.193	<.0001
Practice High complexity	1.869	<.0001	1.543	<.0001	1.815	<.0001	1.552	<.0001
Bene High income	0.699	<.0001	0.702	<.0001	0.702	<.0001	0.705	<.0001
Practice High income	0.834	0.000	0.868	0.003	0.843	0.000	0.875	0.004

Note: In Appendices 9.5 and 9.6, the models predicting per capita costs are as follows.
Appendix 9.5: Random effects patient-level model with indicator for high social risk patient
Appendix 9.6: TIN's Risk-adjusted cost = national average standardized cost * TIN's observed total cost/TIN's predicted total cost
TIN's predicted total cost is calculated in two ways.

1. Patient-level models where observed cost is the outcome, and predictors are HCC risk score, HCC risk score squared, ESRD. This produces CMS risk-adjusted cost.
2. Patient-level models where observed cost is the outcome, and predictors are HCC risk score, HCC risk score squared, ESRD, and flag for presence or absence of beneficiary social risk factor. This produces CMS + SES risk-adjusted cost.

The second-level (practice-level) OLS regression models that include high-social risk practice as the primary predictor are then run with the following outcomes:

1. Q2: CMS-risk-adjusted cost as the dependent variable
2. Q3: CMS + SES risk-adjusted cost as the dependent variable

Appendix 9.5. Association between beneficiary-level social risk factor and per capita costs

Beneficiary SES variables	Average Costs		Adjusted by Risk Score, Risk Score Squared and ESRD	
			Random-effect	
	SES	Rest	Beta	P-value
	Total Per Capita Costs (All Beneficiaries)			
Dual	$ 17,465	$ 10,739	$725	<.0001
Low ZCTA income	$ 12,720	$ 11,481	$230	<.0001
Black	$ 15,492	$ 11,768	-$257	<.0001
Hispanic	$ 13,609	$ 12,035	-$746	<.0001
Rural	$ 11,510	$ 12,278	$251	<.0001
Disabled	$ 14,234	$ 11,496	$455	<.0001
High complexity	$ 22,554	$ 7,605	-$338	<.0001
High income	$ 9,881	$ 12,394	-$175	<.0001
	Heart Failure Per Capita Costs			
Dual	$ 34,809	$ 24,778	$2,979	<.0001
Low ZCTA income	$ 28,368	$ 26,811	$817	<.0001
Black	$ 34,435	$ 26,713	-$85	0.171

Hispanic	$ 31,444	$ 27,447	-$857	<.0001
Rural	$ 25,895	$ 28,161	$412	<.0001
Disabled	$ 32,459	$ 26,170	$2,972	<.0001
High complexity	$ 29,865	$ 22,065	-$4,341	<.0001
High income	$ 23,833	$ 28,012	-$835	<.0001
	Diabetes Per Capita Costs			
Dual	$ 22,533	$ 13,505	$1,972	<.0001
Low ZCTA income	$ 16,564	$ 14,934	$359	<.0001
Black	$ 19,619	$ 15,239	-$284	<.0001
Hispanic	$ 17,461	$ 15,693	-$1,038	<.0001
Rural	$ 14,921	$ 16,069	$254	<.0001
Disabled	$ 19,343	$ 14,576	$1,393	<.0001
High complexity	$ 24,112	$ 9,302	-$630	<.0001
High income	$ 12,826	$ 16,088	-$265	<.0001
	COPD Per Capita Costs			
Dual	$ 29,613	$ 21,921	$2,388	<.0001
Low ZCTA income	$ 24,436	$ 24,071	$471	<.0001
Black	$ 30,462	$ 23,675	$1,379	<.0001
Hispanic	$ 28,078	$ 24,104	$292	0.004
Rural	$ 22,536	$ 24,832	$50	0.452
Disabled	$ 26,190	$ 23,418	$1,140	<.0001
High complexity	$ 29,768	$ 16,420	-$1,318	<.0001
High income	$ 22,021	$ 24,445	-$507	<.0001

Appendix 9.5. Association between beneficiary-level social risk factor and per capita costs (cont'd)

Beneficiary SES variables	Average Costs		Adjusted by Risk Score, Risk Score Squared and ESRD	
			Random-effect	
	SES	Rest	Beta	P-value
	CAD Per Capita Costs			
Dual	$ 27,028	$ 16,208	$2,963	<.0001
Low ZCTA income	$ 19,250	$ 17,566	$593	<.0001
Black	$ 25,743	$ 17,744	$853	<.0001
Hispanic	$ 21,544	$ 18,277	-$738	<.0001
Rural	$ 17,523	$ 18,705	$230	<.0001
Disabled	$ 23,166	$ 17,235	$1,932	<.0001
High complexity	$ 25,172	$ 12,112	-$782	<.0001
High income	$ 14,882	$ 18,872	-$692	<.0001

Appendix 9.6. Association between high-social risk factor practice and per capita costs- among VM eligible practices that met minimum requirement, with each practice weighted equally

Practice top SES flags	Risk-adjusted by CMS risk variables				Risk-adjusted by CMS risk variables + beneficiary SES factors			
	Average Adjusted Cost		Q2 TIN level regression		Average Adjusted Cost		Q3 TIN level regression	
	SES	Rest	Beta	P-value	SES	Rest	Beta	P-value
	Total Per Capita Costs (All Beneficiaries)							
Dual	$ 11,698	$ 11,944	-246.21	0.660	$ 11,301	$ 11,988	-686.99	0.218
Low ZCTA income	$ 12,067	$ 11,875	192.01	0.838	$ 11,979	$ 11,895	83.78	0.928
Black	$ 12,177	$ 11,850	326.47	0.443	$ 12,111	$ 11,860	250.64	0.556
Hispanic	$ 11,674	$ 11,956	-282.03	0.541	$ 11,736	$ 11,939	-202.38	0.661
Rural	$ 12,154	$ 11,847	306.41	0.727	$ 12,263	$ 11,817	446.67	0.620
Disabled	$ 10,438	$ 12,165	-1727.58	0.002	$ 10,327	$ 12,165	-1838.48	0.001
High complexity	$ 14,333	$ 11,129	3203.74	0.000	$ 14,332	$ 11,128	3203.80	0.000
High income	$ 11,731	$ 11,964	-232.68	0.538	$ 11,773	$ 11,951	-178.48	0.637
	Heart Failure Per Capita Costs							
Dual	$ 28,864	$ 26,451	2412.76	0.066	$ 27,401	$ 26,733	667.91	0.580
Low ZCTA income	$ 26,190	$ 26,884	-694.50	0.331	$ 26,085	$ 26,919	-833.83	0.242
Black	$ 27,557	$ 26,587	970.32	0.256	$ 27,353	$ 26,624	728.93	0.394
Hispanic	$	$	-124.19	0.886	$	$	-34.44	0.968

	26,657	26,781			26,723	26,758		
Rural	$ 25,731	$ 27,028	-1296.44	0.070	$ 26,123	$ 26,894	-770.98	0.290
Disabled	$ 26,200	$ 26,838	-637.63	0.629	$ 25,254	$ 26,831	-1577.49	0.205
High complexity	$ 32,066	$ 25,085	6981.35	0.000	$ 32,016	$ 25,065	6950.56	0.000
High income	$ 26,385	$ 26,878	-492.58	0.451	$ 26,496	$ 26,853	-357.02	0.584

Appendix 9.6. Association between high-social risk factor practice and per capita costs (cont'd)
- among VM eligible practices that met minimum requirement, with each practice weighted equally

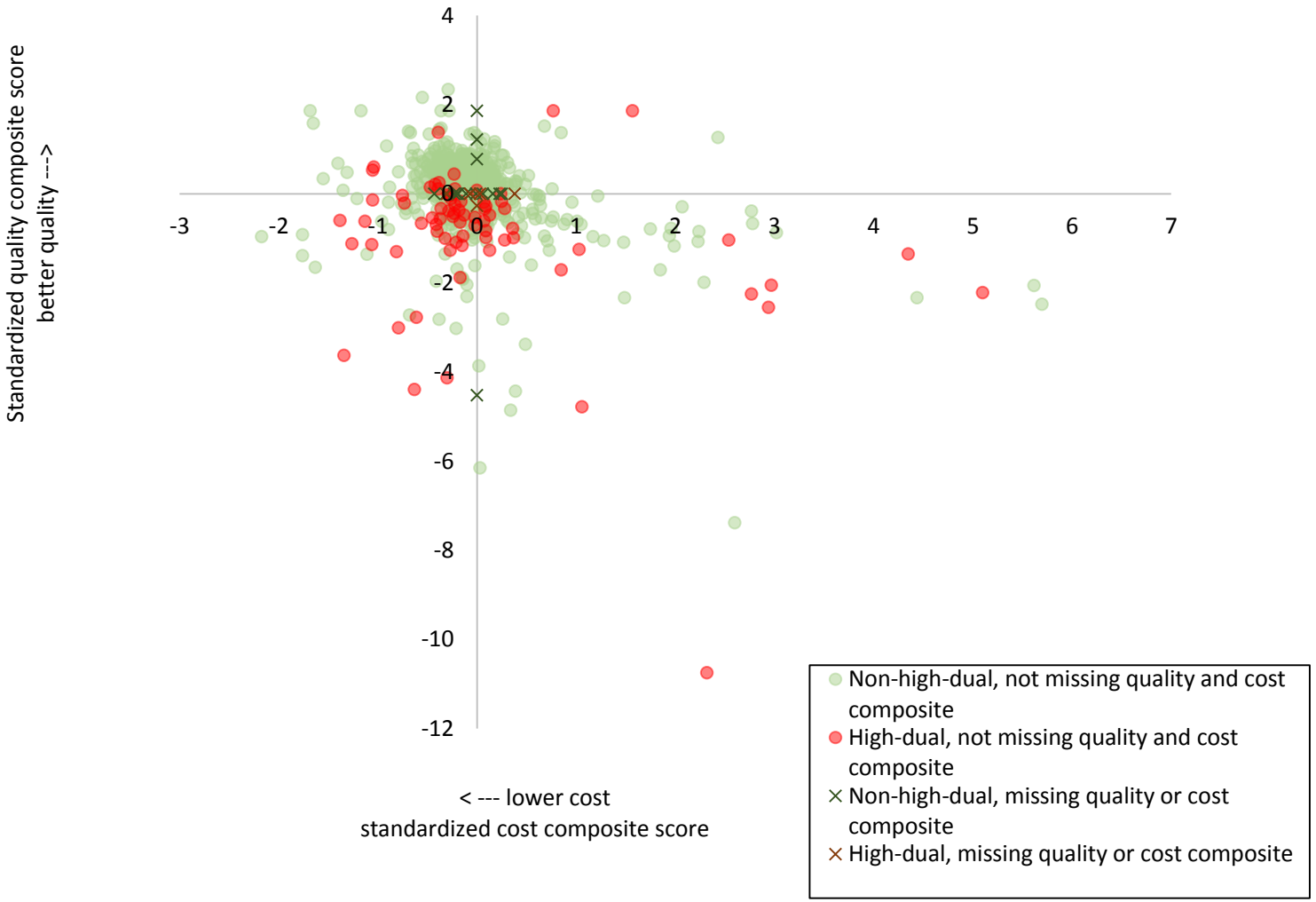
Practice top SES flags	Risk-adjusted by CMS risk variables				Risk-adjusted by CMS risk variables + beneficiary SES factors			
	Average Adjusted Cost		Q2 TIN level regression		Average Adjusted Cost		Q3 TIN level regression	
	SES	Rest	Beta	P-value	SES	Rest	Beta	P-value
	Diabetes Per Capita Costs							
Dual	$ 17,093	$ 15,393	1699.94	0.193	$ 16,155	$ 15,530	624.75	0.596
Low ZCTA income	$ 15,506	$ 15,650	-144.51	0.873	$ 15,377	$ 15,688	-311.55	0.726
Black	$ 16,990	$ 15,312	1678.27	0.093	$ 16,847	$ 15,334	1513.03	0.127
Hispanic	$ 15,743	$ 15,601	142.04	0.849	$ 15,816	$ 15,573	242.58	0.744
Rural	$ 14,936	$ 15,800	-864.08	0.103	$ 15,057	$ 15,761	-703.15	0.188
Disabled	$ 16,343	$ 15,511	832.08	0.555	$ 15,786	$ 15,502	283.99	0.833
High complexity	$ 19,003	$ 14,532	4470.93	0.000	$ 18,998	$ 14,527	4470.88	0.000
High income	$ 15,004	$ 15,811	-807.32	0.068	$ 15,046	$ 15,799	-753.20	0.089
	COPD Per Capita Costs							
Dual	$ 27,752	$ 24,893	2859.16	0.068	$ 26,465	$ 25,075	1390.20	0.352
Low ZCTA income	$ 24,710	$ 25,387	-677.33	0.427	$ 24,739	$ 25,377	-637.80	0.455
Black	$ 27,377	$ 24,792	2585.31	0.012	$ 26,690	$ 24,872	1817.48	0.061
Hispanic	$	$	220.83	0.799	$	$	95.84	0.912

	25,451	25,230			25,350	25,254		
Rural	$ 23,885	$ 25,624	-1739.66	0.008	$ 24,349	$ 25,405	-1056.06	0.108
Disabled	$ 26,271	$ 25,126	1145.34	0.449	$ 25,882	$ 25,121	761.31	0.607
High complexity	$ 30,284	$ 23,673	6610.78	0.000	$ 30,274	$ 23,670	6604.27	0.000
High income	$ 25,405	$ 25,223	181.92	0.820	$ 25,468	$ 25,211	257.66	0.747

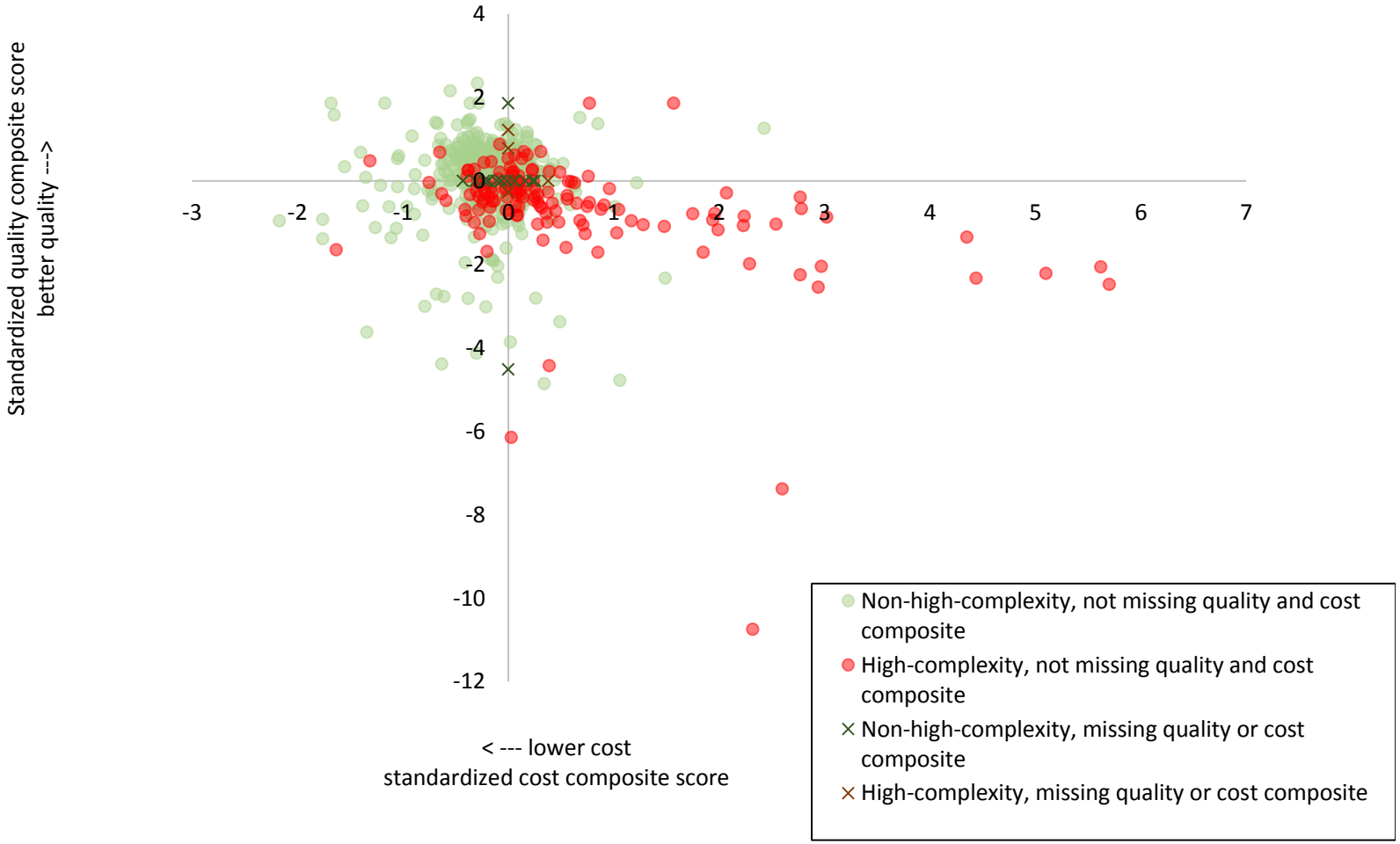
Appendix 9.6. Association between high-social risk factor practice and per capita costs (cont'd)
- among VM eligible practices that met minimum requirement, with each practice weighted equally

Practice top SES flags	Risk-adjusted by CMS risk variables				Risk-adjusted by CMS risk variables + beneficiary SES factors			
	Average Adjusted Cost		Q2 TIN level regression		Average Adjusted Cost		Q3 TIN level regression	
	SES	Rest	Beta	P-value	SES	Rest	Beta	P-value
	CAD Per Capita Costs							
Dual	$ 20,620	$ 18,271	2349.05	0.034	$ 19,361	$ 18,468	893.48	0.386
Low ZCTA income	$ 17,970	$ 18,707	-737.70	0.264	$ 17,820	$ 18,748	-927.10	0.156
Black	$ 20,662	$ 18,112	2550.09	0.062	$ 20,291	$ 18,171	2120.66	0.126
Hispanic	$ 18,872	$ 18,520	352.39	0.642	$ 18,891	$ 18,512	378.70	0.617
Rural	$ 18,374	$ 18,628	-254.48	0.826	$ 18,514	$ 18,578	-63.93	0.956
Disabled	$ 20,005	$ 18,365	1640.15	0.395	$ 19,065	$ 18,351	714.62	0.668
High complexity	$ 23,317	$ 17,063	6253.65	0.000	$ 23,319	$ 17,063	6256.12	0.000
High income	$ 18,929	$ 18,466	463.21	0.654	$ 19,037	$ 18,434	603.15	0.555

Appendix 9.7. Scatterplot of practice performance on cost and quality composite, stratified by high-dual vs. other practice, for practices meeting the minimum reporting requirements and with at least a non-missing cost or quality composite score



Appendix 9.8. Scatterplot of practice performance on cost and quality composite, stratified by high-complexity vs. other practice, for practices meeting the minimum reporting requirements and with at least a non-missing cost or quality composite score



Appendix 9.9. Value Modifier by High-Dual or High-Complexity Practice vs. Other Practice, Among VM-Eligible Practices Meeting Minimum Reporting Requirements, Stratified by Selection of Quality Tiering

		High-dual (N=88)			Other (N=618)		
		Low quality	**Average quality**	**High quality**	**Low quality**	**Average quality**	**High quality**
QT (N=112)	**Low cost**	0.0%	5.9%	0.0%	0.0%	1.1%	0.0%
	Average cost	17.6%	70.6%	0.0%	2.1%	78.9%	14.7%
	High cost	5.9%	0.0%	0.0%	1.1%	2.1%	0.0%
Non-QT (N=594)	**Low cost**	4.2%	5.6%	0.0%	0.6%	1.1%	0.6%
	Average cost	14.1%	60.6%	2.8%	4.2%	86.8%	2.7%
	High cost	11.3%	0.0%	1.4%	1.9%	1.9%	0.2%

		High-complexity (N=155)			Other (N=551)		
		Low quality	Average quality	High quality	Low quality	Average quality	High quality
QT (N=112)	Low cost	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%
	Average cost	11.8%	64.7%	0.0%	3.2%	80.0%	14.7%
	High cost	11.8%	11.8%	0.0%	0.0%	0.0%	0.0%
Non-QT (N=594)	Low cost	0.7%	0.7%	0.0%	1.1%	2.0%	0.7%
	Average cost	6.5%	73.2%	0.7%	5.0%	86.8%	3.3%
	High cost	11.6%	5.8%	0.7%	0.4%	0.4%	0.2%

Appendix Chapter 11: The End-Stage Renal Disease Quality Incentive Program

Detailed Methodology

The current analysis aims to evaluate whether Medicare End-Stage Renal Disease (ESRD) beneficiaries with specific social and related risk factors – income level (defined by the geographic area-level median income, as well as whether the beneficiary is eligible for Medicaid coverage), race/ethnicity, disability, and rurality – differ in their achievement of the ESRD Quality Incentive Program (QIP) performance standards, when compared to other ESRD beneficiaries. It also aims to evaluate whether dialysis facilities serving a larger share of vulnerable beneficiaries differ in their performance on the QIP quality measures, after accounting for the Social risk factors of the beneficiaries they serve. This memo describes the methods for the creation of the analytic dataset, as well as the specifications of the statistical analyses conducted.

Data Sources

This analysis utilized data from a number of different sources, as described below:

(i) Medicare enrollment data from the Common Medicare Environment (CME), the Medicare Enrollment Database (EDB), and the Master Beneficiary Summary File (MBSF),

(ii) Administrative claims data from the Medicare Parts A/B fee-for-service (FFS) Claims Database,

(iii) Geographical data from the 2014 UDS Mapper ZIP to ZIP Code Tabulation Area (ZCTA) Crosswalk, the 2012 Dartmouth ZIP to Hospital Service Area (HSA) Crosswalk, and the ZIP to Metropolitan Statistical Area (MSA) Crosswalk

(iv) Aggregated ZCTA population size and income information from the 2013 American Community Survey (ACS) 5-year estimates,

(v) ESRD facility performance data from the Payment Year (PY) 2015 ESRD QIP Performance Score Summary Report, and

(vi) ESRD facility Calendar Year (CY) 2013 performance data on the measures included in the Centers for Medicare & Medicaid Services' (CMS') Dialysis Facility Compare (DFC) Five-Star Quality Rating System

Study Population

The study population included all fee-for-service beneficiaries with Medicare as the primary payer who received outpatient maintenance dialysis, as evidenced by having an outpatient type of bill

72x claim, in at least one month in CY 2013 – the time period that corresponds to the performance measure period for the PY 2015 ESRD QIP. The unit of analysis for this study was beneficiary-facility-month, which is consistent with the monthly submission cycle of ESRD claims. Each beneficiary contributed an observation for every month (or partial month) during which they received dialysis treatment at a specific ESRD facility. In the case where a beneficiary switched facilities during the month, the beneficiary contributed one observation for the first facility in that month and another observation for the second facility in the same month. For a beneficiary-facility-month to be eligible for analysis, it must have met the following criteria:

1. The beneficiary must have been enrolled in Medicare Parts A (inpatient) and B (outpatient), but not Part C, during that month.
2. For evaluating the QIP-related outcomes, the beneficiary must have undergone dialysis at a facility that received a QIP score for Payment Year 2015, and specifically a score for the QIP measure of interest.
3. The beneficiary must have been at least 18 years of age as of the first day of that month.
4. For evaluating the hemodialysis dialysis adequacy (hemodialysis Kt/V) and Vascular Access Type (VAT) outcomes, the beneficiary must have received hemodialysis treatment during that month.
5. For evaluating the peritoneal dialysis adequacy (peritoneal dialysis Kt/V) outcome, the beneficiary must have received peritoneal dialysis treatment during that month.

For each outcome of interest, the study analyzed all beneficiary-months that met the eligibility criteria detailed above. Since beneficiary-months may be eligible for some outcomes, but not for others, the total study population differed slightly for each outcome.

Outcomes

Eight outcomes were selected as the outcomes of interest for this analysis. These included five of the six clinical measures included in the PY 2015 QIP measure set and an additional three measures used in the creation of Five-Star Ratings for dialysis facilities.

i. QIP measure: Hemoglobin (Hgb) > 12 g/dL
ii. QIP measure: Vascular Access Type: access via arteriovenous fistula (AVF)
iii. QIP measure: Vascular Access Type: access via long-term catheter
iv. QIP measure: Hemodialysis Kt/V > 1.2
v. QIP measure: Peritoneal dialysis Kt/V > 1.7
vi. Star Ratings measure: Standardized Hospitalization Ratio (SHR)
vii. Star Ratings measure: Standardized Transfusion Ratio (STrR)

viii. Star Ratings measure: Standardized Mortality Ratio (SMR)

The pediatric hemodialysis QIP clinical measure was excluded from the analysis due to the small number of pediatric patients in the ESRD population. The QIP measure outcomes were constructed using clinical values reported on the last dialysis treatment of the month for each beneficiary-facility pair. Presence of long-term catheter in a given month was defined as having a claim in that month and in each of the previous two months with an indication of use of catheter and no other vascular access, regardless of facility where beneficiary received dialysis in the previous two months. Analyses on the Star Ratings measures were only conducted using the reported facility-level standardized ratio measure scores on Dialysis Facility Compare.

Social and related risk factors of Interest

The variables of interest in this analysis were beneficiary social and related risk factors. Information on race/ethnicity and disability were readily available from the Medicare Enrollment Database (EDB), the Common Medicare Environment (CME), and the Master Beneficiary Summary File (MBSF) databases. A beneficiary was defined as rural if their home zip code lies outside a Metropolitan Statistical Area (MSA), as defined by the US Census Bureau. Income levels for beneficiaries were defined using two different metrics – zip-code level median income and beneficiary's dual eligibility status. A beneficiary who was classified as dual-eligible in the month of analysis is one who was eligible to be enrolled in a Medicare Savings Program (Qualified Medicare Beneficiary (QMB) Program, Specified Low-Income Medicare Beneficiary (SLMB) Program, Qualifying Individual (QI) Program, or the Qualified Disabled and Working Individuals (QDWI) Program) in that month. The zip-code level median income is the median income reported in the 5-year American Community Survey (ACS) for the Zip Code Tabulation Area associated with the beneficiary's home zip code for the month of analysis.

In addition to beneficiary social risk factors, the other variables of interest for the analysis were facility-level social risk factors. In most cases, facility characteristics are an aggregation of the Social risk factors of the beneficiaries served at that facility in the month of analysis. The "Proportion Duals" covariate was defined as the share of all beneficiaries at a facility in a given month who are dual-eligible. The same methodology is applied to define the "Proportion Disabled" and "Proportion Minority" covariates. The ZCTA-level median income outcome for a facility is the weighted average of zip-code level median income for all beneficiary-months at the facility. Two additional covariates were defined based on the location of the facility. A facility was defined as rural provider if its zip code is not part of an MSA. All facility SES characteristic variables were converted to binary variables, where facilities that are in the bottom 20^{th} percentile of all facilities for the income covariates, and in the top 20^{th} percentile for the other covariates were considered safety-net facilities for that characteristic.

The specific definitions and methodology for each social risk variable are provided in Table 1.

Regression Analyses

This analysis aimed to answer three questions:

1. Did beneficiaries with certain social risk factors have worse outcomes on QIP measures than beneficiaries who did not share those characteristics?
2. Did beneficiaries who were receiving care at safety-net facilities experience worse outcomes than beneficiaries treated at other facilities?
3. What are the relative contributions of facility-level and beneficiary-level social risk factors to beneficiary QIP outcomes?

Two sets of models were used to evaluate each of these three questions. The first set consisted of simple binomial models, estimated using generalized linear modeling (GLM), which treated each beneficiary-facility-month as a "trial", with the "success" being defined by the occurrence of an outcome. Since a single beneficiary could contribute more than one beneficiary-facility-month, an overdispersion factor was included in the model to account for the correlation between the outcomes for the same beneficiary. These models did not account for possible facility-level effects.

The second set aimed to account for facility-level effects on beneficiary outcomes. The population-averaged model, which uses the generalized estimating equations (GEE) estimation method, provides similar estimates to the simple binomial model, but also adjusts variance estimates to account for the non-independence of outcomes among beneficiaries treated at the same facility[4-6].

Research Question 1

Four separate models were run to evaluate the impact of individual beneficiary social risk factors on beneficiary outcomes.

- Model 1.1: Univariate simple binomial model, with an overdispersion factor, modeled using GLM.
    - *Outcome = SOCIAL RISK*$_i$, where SOCIAL RISK$_i$ refers to each SOCIAL RISK characteristic of interest
- Model 1.2: Multivariate simple binomial model, with an overdispersion factor, modeled using GLM
    - *Outcome = SOCIAL RISK*, where SOCIAL RISK refers to all beneficiary level SOCIAL RISK characteristic of interest
- Model 1.3: Univariate population averaged model, modeled using GEE
    - *Outcome = SOCIAL RISK*$_i$, where SOCIAL RISK$_i$ refers to each SOCIAL RISK characteristic of interest
- Model 1.4: Multivariate population averaged model, modeled using GEE

- *Outcome = SOCIAL RISK*, where SOCIAL RISK refers to all beneficiary level SOCIAL RISK characteristic of interest

Research Question 2

Similarly, four separate models were run to evaluate the impact of facility-level social risk factors on beneficiary outcomes.

- Model 2.1: Univariate simple binomial model, with an overdispersion factor, modeled using GLM
  - *Outcome = SOCIAL RISK$_i$*, where SOCIAL RISK$_i$ refers to each facility-level SOCIAL RISK characteristic of interest
- Model 2.2: Multivariate simple binomial model, with an overdispersion factor, modeled using GLM
  - *Outcome = SOCIAL RISK*, where SOCIAL RISK refers to all facility-level Social risk factors of interest
- Model 2.3: Univariate population averaged model, modeled using GEE
  - *Outcome = SOCIAL RISK$_i$*, where SOCIAL RISK$_i$ refers to each facility-level SOCIAL RISK characteristic of interest
- Model 2.4: Multivariate population averaged model, modeled using GEE
  - *Outcome = SOCIAL RISK*, where SOCIAL RISK refers to all facility-level Social risk factors of interest

Research Question 3

Finally, two separate models were run to identify the contribution of beneficiary-level and facility-level Social risk factors on beneficiary outcomes.

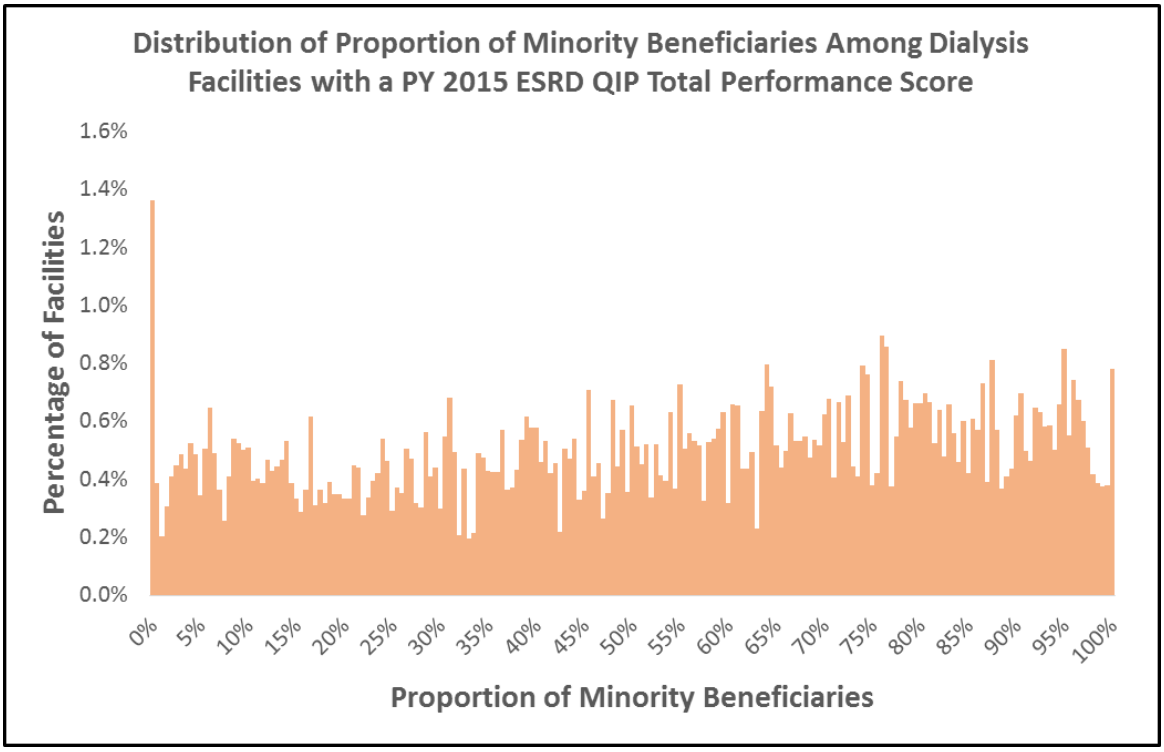
- Model 3.1: Multivariate simple binomial model, with an overdispersion factor, modeled using GLM
  - *Outcome = SOCIAL RISK$_b$ + SOCIAL RISK$_f$*, where SOCIAL RISK$_b$ refers to all beneficiary-level social risk factors, and SOCIAL RISK$_f$ refers to all facility-level social risk factors
- Model 3.2: Multivariate population averaged model, modeled using GEE
  - *Outcome = SOCIAL RISK$_b$ + SOCIAL RISK$_f$*, where SOCIAL RISK$_b$ refers to all beneficiary-level social risk factors, and SOCIAL RISK$_f$ refers to all facility-level social risk factors

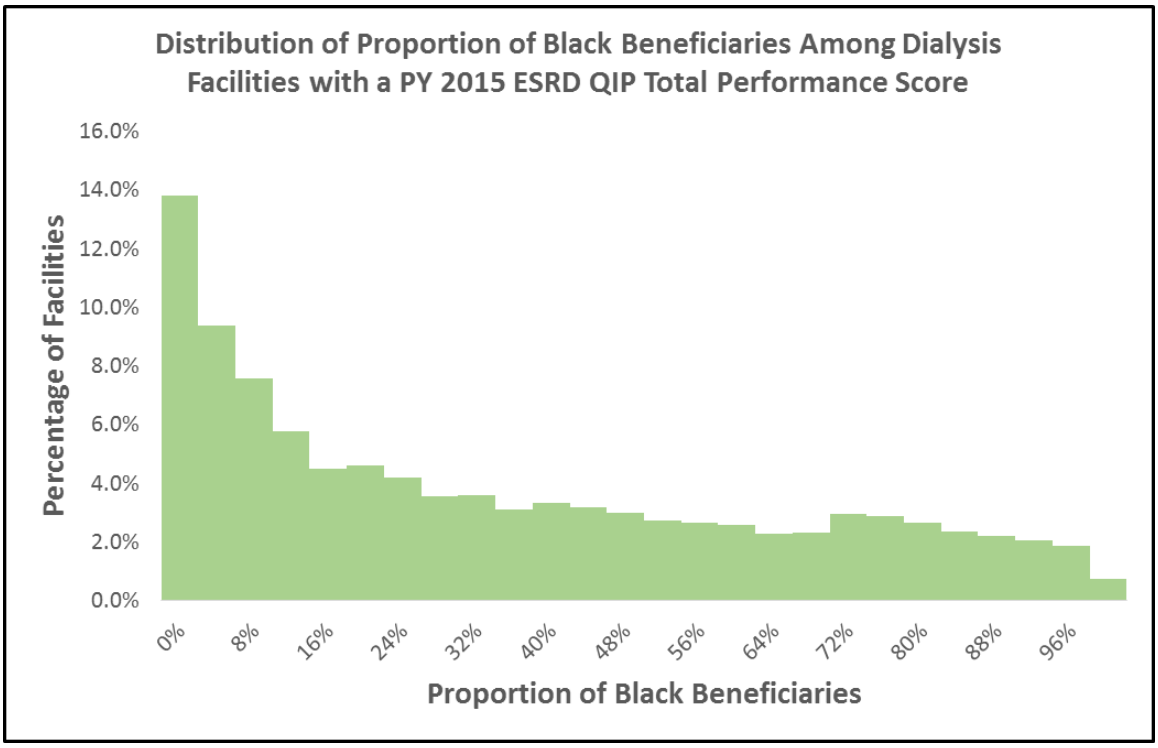
Appendix Table 11.1: Definitions for Social and Related Risk Factors

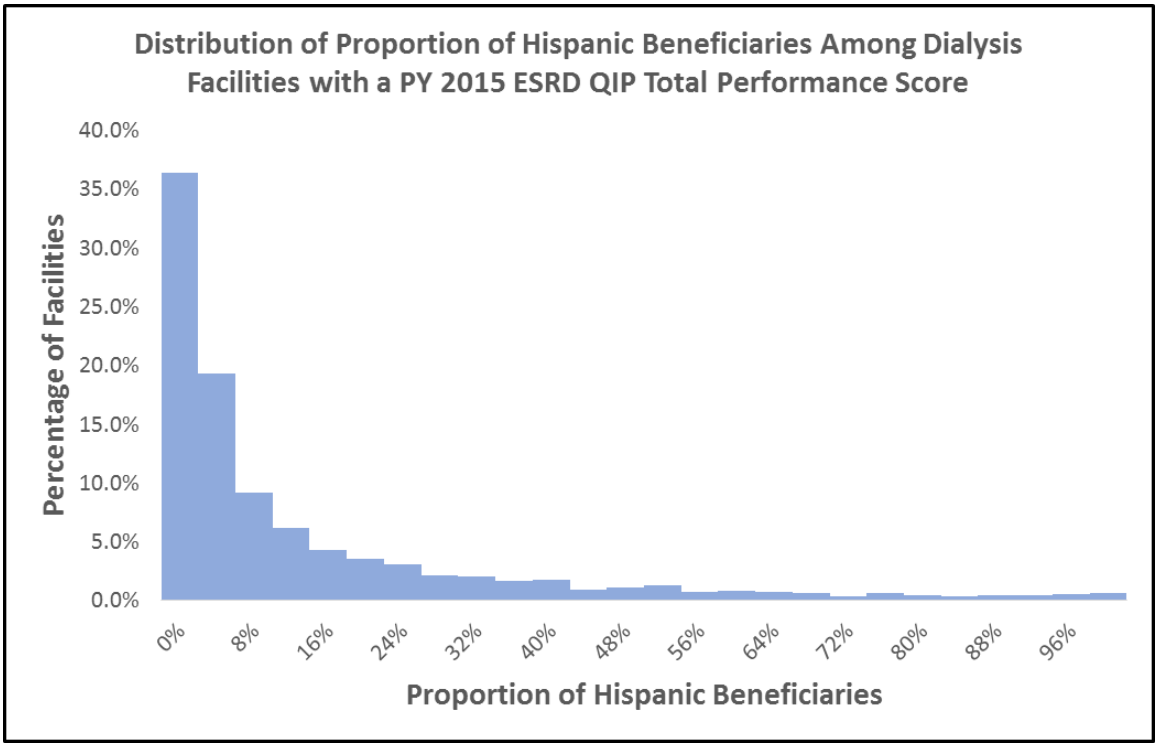
Social and Related Risk Factors	Source	Specification
Dual Status	Common Medicare Environment	If the DUAL_STUS_CD variable is part of the list below , the beneficiary is deemed dual enrolled in the month of treatment at a particular facility 01 = Eligible is entitled to Medicare- QMB only 02 = Eligible is entitled to Medicare- QMB AND Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) 03 = Eligible is entitled to Medicare- SLMB only 04 = Eligible is entitled to Medicare- SLMB AND Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005) 05 = Eligible is entitled to Medicare- QDWI 06 = Eligible is entitled to Medicare- Qualifying individuals 07 = Missing in latest data dictionary and shows up rarely (<.001%); consulting with analogous MAX variable suggested that this is the same as 06 08 = Eligible is entitled to Medicare- Other Full Dual Eligibles (Non QMB, SLMB,QWDI or QI) with Medicaid coverage including RX (Medicaid drug coverage criterion only applies through December 2005)
ZCTA-Level Median Income	CMS EDB 5-year ACS estimates	1. Beneficiary mailing zip code information was taken from the EDB (earliest mailing address during treatment month) for each month beneficiary was in the ESRD and facility's population during CY 2013 2. Zip codes were mapped to ZCTAs using the UDS Mapper Zip to ZCTA crosswalk (2014), and ZCTA median income was appended 3. Provider-level income value was computed as a weighted average of median zip code income among all beneficiary-months in facility's population during CY 2013

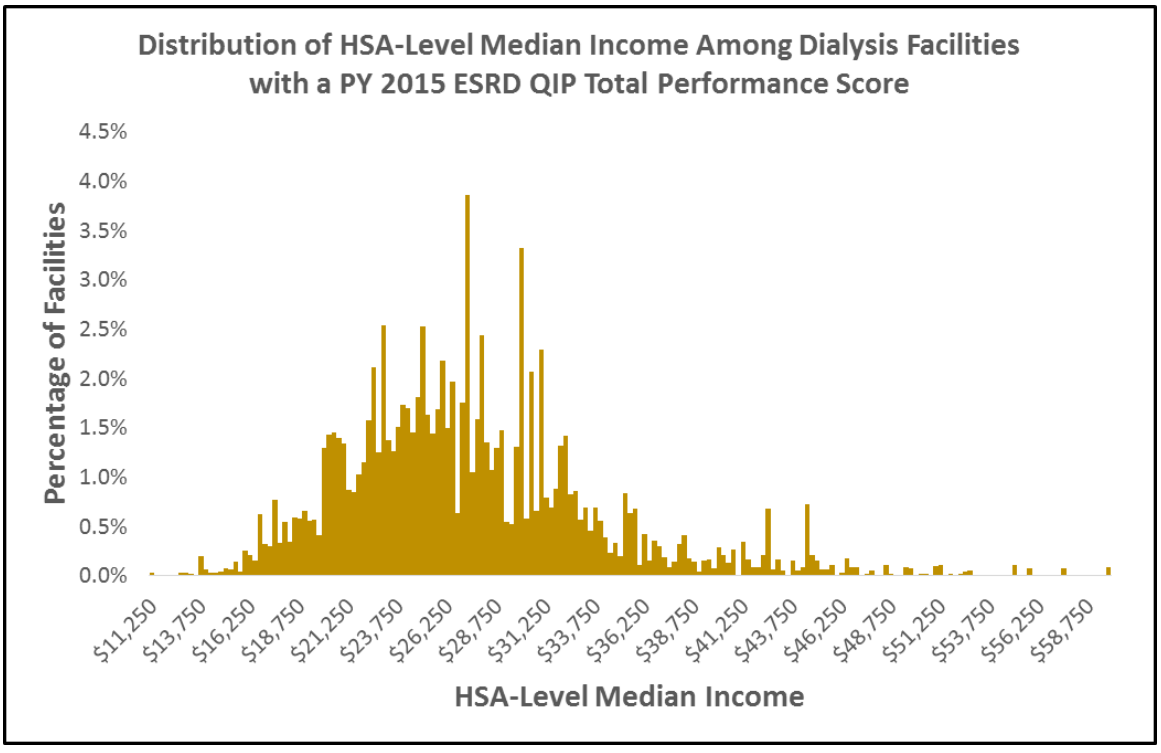
HSA-Level Median Income	CMS EDB 5-year ACS estimates	1. Dialysis facility zip codes were obtained from the PY 2015 ESRD QIP Performance Score Report 2. Zip codes were mapped to their corresponding HSA using the Dartmouth Zip to HSA crosswalk (2012) and mapped to ZCTA using the UDS Mapper Zip to ZCTA crosswalk (2014) 3. Median income and the population of each ZCTA was obtained from the ACS 5-yr data (2013) 4. For each HSA, total HSA population was calculated by summing up the population for ZCTAs within the HSA with non-missing income values 5. Weighted HSA income then was calculated by multiplying each non-missing ZCTA income value by the percent of the HSA population in the ZCTA and summing these values for ZCTAs in the HSA
Minority-Serving Status	MBSF	Relevant race codes: RTI Race Code = 2 (BLACK OR AFRICAN-AMERICAN) RTI Race Code = 5 (HISPANIC)
Rural Provider	PY 2015 Score Report Census MSA/county mapping	Dialysis facility zip codes were obtained from the PY 2015 ESRD QIP Performance Score Report and were mapped to MSAs. If the facility zip was NOT part of an MSA, the facility was deemed a "Rural" provider.
Rural Beneficiary	CMS EDB Census MSA/county mapping	Beneficiary mailing zip code information was taken from the EDB (earliest mailing address during treatment month) for each month beneficiary was in the ESRD and facility's population during CY 2013. If the beneficiary zip was NOT part of an MSA, the beneficiary was deemed a "Rural" beneficiary.
Disabled	CMS EDB	If the **original** reason for Medicare enrollment indicates disability or disability with ESRD, then the beneficiary is considered disabled

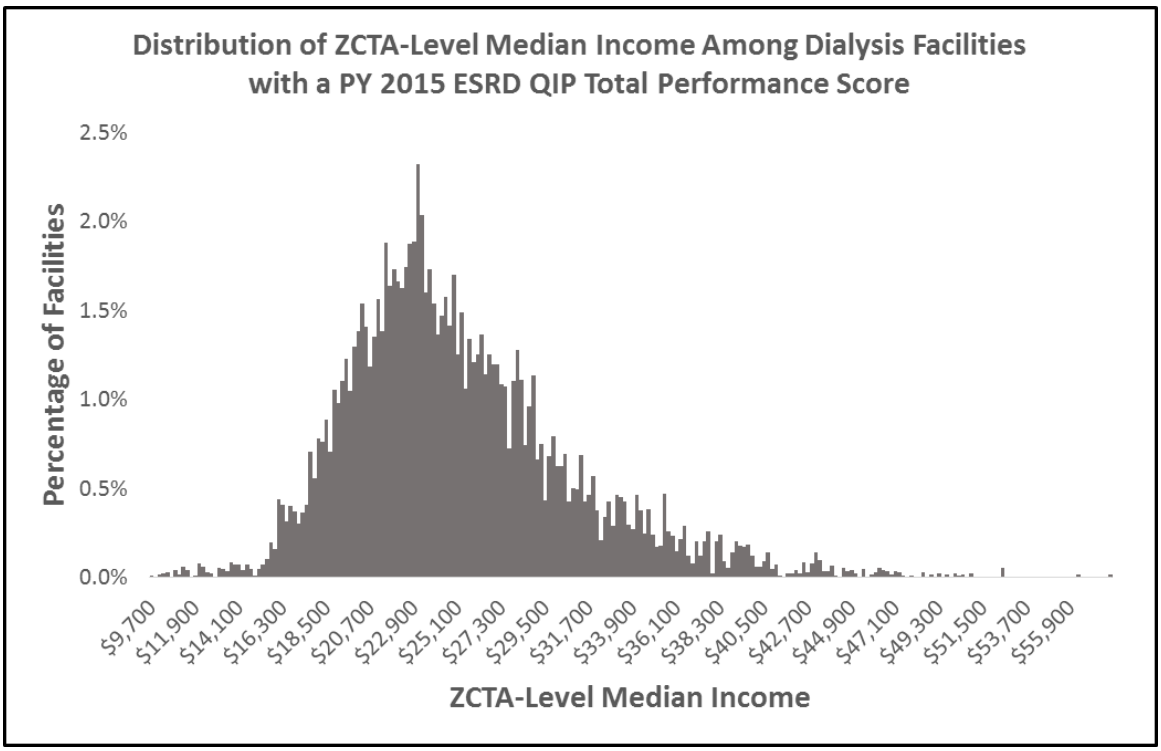
Appendix Figure 11.1 Distributions of additional social risk factors across dialysis facilities

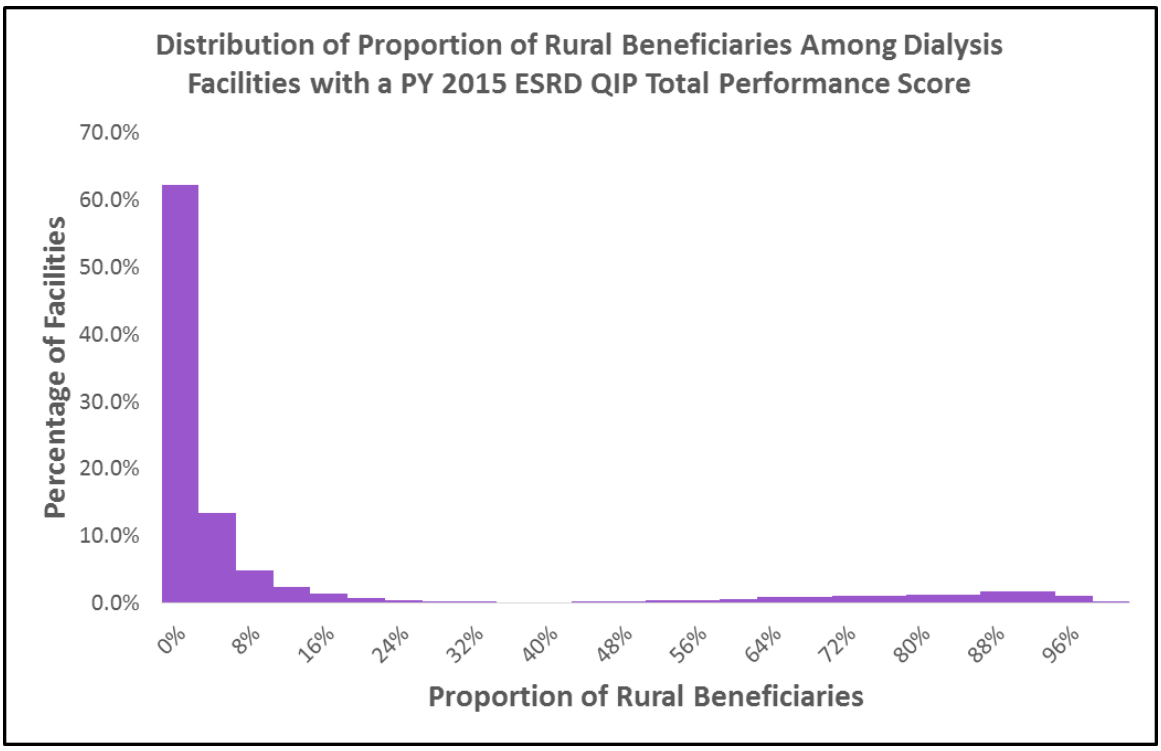


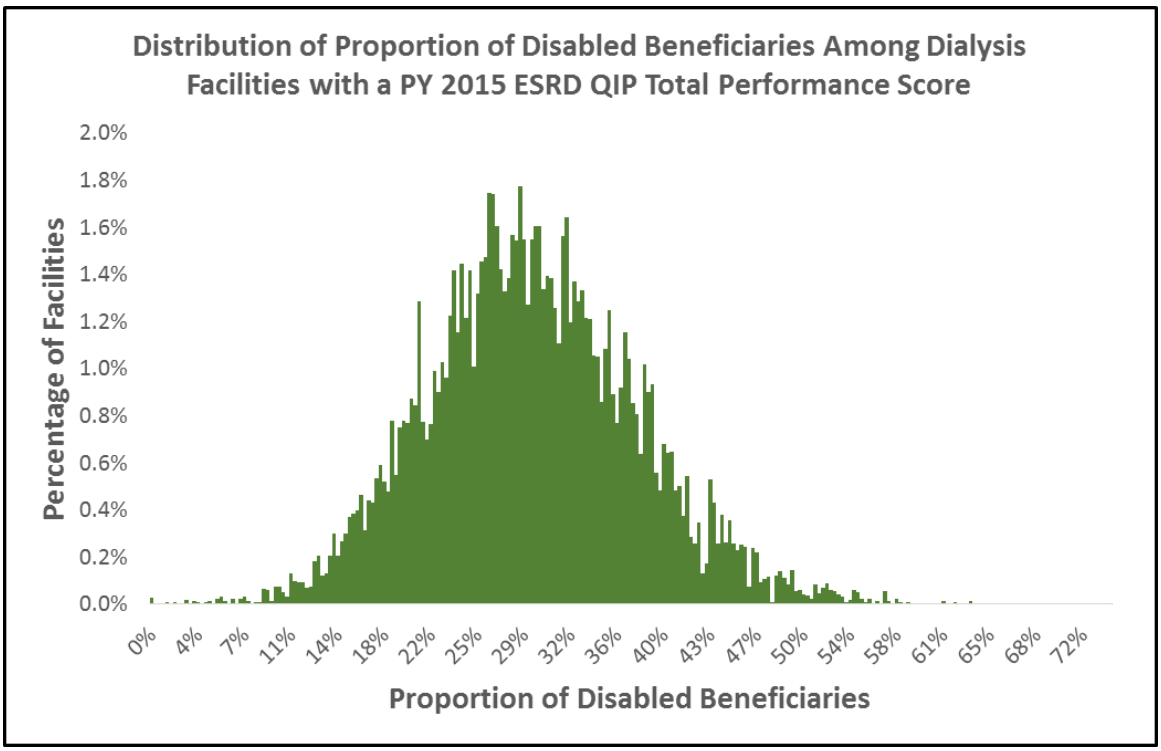



Distribution of Proportion of Hispanic Beneficiaries Among Dialysis Facilities with a PY 2015 ESRD QIP Total Performance Score
Percentage of Facilities
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0%
8%
16%
24%
32%
40%
48%
56%
64%
72%
80%
88%
96%
Proportion of Hispanic Beneficiaries


Distribution of HSA-Level Median Income Among Dialysis Facilities with a PY 2015 ESRD QIP Total Performance Score
Percentage of Facilities
4.5%
4.0%
3.5%
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
$11,250
$13,750
$16,250
$18,750
$21,250
$23,750
$26,250
$28,750
$31,250
$33,750
$36,250
$38,750
$41,250
$43,750
$46,250
$48,750
$51,250
$53,750
$56,250
$58,750
HSA-Level Median Income


Distribution of ZCTA-Level Median Income Among Dialysis Facilities with a PY 2015 ESRD QIP Total Performance Score
Percentage of Facilities
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
$9,700
$11,900
$14,100
$16,300
$18,500
$20,700
$22,900
$25,100
$27,300
$29,500
$31,700
$33,900
$36,100
$38,300
$40,500
$42,700
$44,900
$47,100
$49,300
$51,500
$53,700
$55,900
ZCTA-Level Median Income


Distribution of Proportion of Rural Beneficiaries Among Dialysis Facilities with a PY 2015 ESRD QIP Total Performance Score
Percentage of Facilities
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0%
8%
16%
24%
32%
40%
48%
56%
64%
72%
80%
88%
96%
Proportion of Rural Beneficiaries


Distribution of Proportion of Disabled Beneficiaries Among Dialysis Facilities with a PY 2015 ESRD QIP Total Performance Score
Percentage of Facilities
2.0%
1.8%
1.6%
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
0%
4%
7%
11%
14%
18%
22%
25%
29%
32%
36%
40%
43%
47%
50%
54%
58%
61%
65%
68%
72%
Proportion of Disabled Beneficiaries

Appendix Table 11.1 Raw performance rates for PY 2015 ESRD QIP quality measures, by social risk factor

Beneficiary-Month-Level Measure Rates for the PY 2015 QIP Measures During the CY 2013 Performance Period, by SES-Related Patient Characteristics

SES Category	Patient Group	PY2015 QIP Measures					
		Hgb > 12	Kt/V Adult Hemodialysis	Kt/V Adult Peritoneal Dialysis	Kt/V Pediatric Hemodialysis	Fistula	Long Term Catheter
Minority	Non-Minority	4.5%	96.0%	92.3%	92.9%	65.5%	11.1%
	Minority	**4.5%**	**96.4%**	**91.0%**	**90.8%**	**60.0%**	**9.2%**
Black	Not Black	4.6%	96.4%	92.1%	92.3%	66.2%	10.4%
	Black	**4.4%**	**96.0%**	**90.9%**	**91.3%**	**56.6%**	**9.6%**
Hispanic	Not Hispanic	4.4%	96.0%	91.9%	92.6%	61.4%	10.4%
	Hispanic	**4.9%**	**97.3%**	**91.3%**	**90.4%**	**68.2%**	**8.3%**
Disabled	Non-Disabled	4.5%	96.6%	91.9%	92.2%	63.8%	9.7%
	Disabled	**4.5%**	**95.4%**	**91.5%**	**33.3%**	**59.3%**	**11.0%**
Dual	Non-Dual	4.4%	96.4%	92.0%	92.0%	64.5%	9.5%
	Dual	**4.6%**	**96.1%**	**91.4%**	**92.1%**	**60.5%**	**10.6%**
Rural	Urban	4.5%	96.3%	91.8%	93.3%	62.4%	10.1%
	Rural	**4.4%**	**96.2%**	**92.3%**	**88.6%**	**63.4%**	**10.1%**

Appendix Table 11.2 PY 2015 ESRD QIP quality measures and facility level of social risk factors, modeled with patient-level and facility-level factors in a single model

KEY: Better odds of meeting QIP targets | Worse odds of meeting QIP targets

Patient-Level and Facility-Level SES Factors Combined

Relationship with Performance on the ESRD QIP Hemoglobin > 12 g/dL Measure

SES Factor	Simple Binomial Model			Population-Averaged Model		
	Odds Ratio	95% Conf. Interval		Odds Ratio	95% Conf. Interval	
		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Disabled	1.000	0.983	1.016	1.007	0.978	1.037
Dual	1.068	1.051	1.085	1.088	1.057	1.119
Black	0.967	0.948	0.985	0.925	0.890	0.961
Hispanic	1.064	1.038	1.091	1.051	1.001	1.103
Low Income*	1.026	1.009	1.042	1.019	0.990	1.049
Rural	1.073	1.045	1.103	1.089	1.026	1.155
Top 20% of Disabled-Serving	0.974	0.954	0.995	1.099	0.991	1.218
Top 20% of Dual-Serving	1.051	1.030	1.073	1.031	0.912	1.165
Top 20% of Black-Serving	0.999	0.977	1.021	0.926	0.818	1.049
Top 20% of Hispanic-Serving	0.970	0.948	0.993	0.920	0.811	1.044
Low Income-Serving	0.988	0.967	1.010	0.901	0.797	1.018
Rural Provider	0.896	0.871	0.923	1.083	0.974	1.204

Relationship with Performance on the ESRD QIP Fistula Measure

SES Factor	Simple Binomial Model			Population-Averaged Model		
	Odds Ratio	95% Conf. Interval		Odds Ratio	95% Conf. Interval	
		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Disabled	0.867	0.854	0.880	0.868	0.855	0.882
Dual	0.863	0.851	0.876	0.853	0.840	0.866
Black	0.716	0.704	0.729	0.734	0.719	0.749
Hispanic	1.196	1.167	1.225	1.244	1.210	1.279
Low Income*	1.019	1.004	1.034	1.035	1.018	1.051
Rural	0.911	0.888	0.935	0.878	0.852	0.905
Top 20% of Disabled-Serving	0.999	0.980	1.019	0.992	0.958	1.027
Top 20% of Dual-Serving	1.019	1.001	1.039	1.014	0.977	1.053
Top 20% of Black-Serving	0.941	0.922	0.960	0.915	0.883	0.949
Top 20% of Hispanic-Serving	0.964	0.944	0.985	0.968	0.932	1.005
Low Income-Serving	0.935	0.916	0.953	0.940	0.904	0.978
Rural Provider	1.156	1.125	1.188	1.180	1.133	1.228

Relationship with Performance on the ESRD QIP Long-Term Catheter Measure

SES Factor	Simple Binomial Model			Population-Averaged Model		
	Odds Ratio	95% Conf. Interval		Odds Ratio	95% Conf. Interval	
		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Disabled	1.154	1.131	1.177	1.156	1.131	1.182
Dual	1.201	1.178	1.224	1.210	1.184	1.236
Black	0.825	0.806	0.844	0.820	0.796	0.845
Hispanic	0.709	0.686	0.732	0.685	0.658	0.713
Low Income*	0.950	0.932	0.968	0.942	0.921	0.964
Rural	1.279	1.238	1.322	1.391	1.335	1.450
Top 20% of Disabled-Serving	1.008	0.983	1.034	1.015	0.962	1.070

Top 20% of Dual-Serving	1.024	0.998	1.050	1.025	0.967	1.086
Top 20% of Black-Serving	0.954	0.929	0.980	0.928	0.878	0.981
Top 20% of Hispanic-Serving	0.950	0.924	0.978	0.932	0.881	0.986
Low Income-Serving	0.970	0.944	0.997	0.928	0.872	0.987
Rural Provider	0.753	0.727	0.780	0.726	0.683	0.772

Relationship with Performance on the ESRD QIP Hemodialysis Kt/V Measure

SES Factor	Simple Binomial Model			Population-Averaged Model		
	Odds Ratio	95% Conf. Interval		Odds Ratio	95% Conf. Interval	
		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Disabled	0.727	0.708	0.747	0.690	0.664	0.716
Dual	0.881	0.858	0.906	0.869	0.833	0.907
Black	0.991	0.960	1.023	1.005	0.953	1.061
Hispanic	1.606	1.531	1.684	1.820	1.672	1.980
Low Income*	0.986	0.960	1.013	0.992	0.951	1.034
Rural	0.684	0.653	0.716	0.589	0.539	0.644
Top 20% of Disabled-Serving	1.042	1.006	1.080	1.050	0.959	1.149
Top 20% of Dual-Serving	0.919	0.888	0.951	0.868	0.792	0.951
Top 20% of Black-Serving	1.043	1.006	1.083	1.196	1.083	1.321
Top 20% of Hispanic-Serving	0.921	0.886	0.957	0.926	0.843	1.018
Low Income-Serving	1.058	1.020	1.098	1.092	0.979	1.219
Rural Provider	1.416	1.348	1.489	1.497	1.330	1.686

Relationship with Performance on the ESRD QIP Peritoneal Dialysis Kt/V Measure

SES Factor	Simple Binomial Model			Population-Averaged Model		
	Odds Ratio	95% Conf. Interval		Odds Ratio	95% Conf. Interval	
		Lower Bound	Upper Bound		Lower Bound	Upper Bound

Disabled	0.966	0.901	1.036	0.964	0.900	1.033
Dual	0.952	0.895	1.013	0.955	0.894	1.019
Black	0.826	0.768	0.889	0.794	0.732	0.861
Hispanic	0.886	0.803	0.977	0.861	0.775	0.957
Low Income*	1.039	0.977	1.104	1.039	0.976	1.107
Rural	0.940	0.872	1.014	0.936	0.859	1.020
Top 20% of Disabled-Serving	1.045	0.957	1.141	1.083	0.903	1.298
Top 20% of Dual-Serving	0.872	0.799	0.951	0.913	0.741	1.123
Top 20% of Black-Serving	1.062	0.972	1.161	1.099	0.932	1.295
Top 20% of Hispanic-Serving	1.140	1.038	1.251	1.157	0.947	1.414
Low Income-Serving	0.953	0.869	1.045	0.925	0.748	1.143
Rural Provider	1.298	1.158	1.455	1.393	1.130	1.716

*This category represents beneficiaries in the bottom 20% of ZCTA-level income.

Appendix Table 11.3 Facility-level reporting-only measure scores

Facility Type	Patient Experience of Care Reporting	NHSN Reporting	Mineral Metabolism Reporting	Anemia Management Reporting
National Average	9.80	9.81	9.57	9.91
High-Dual	**9.66**	**9.70**	**9.61**	**9.87**
High-Disabled	**9.72**	9.81	**9.53**	9.92
High-Black	9.76	9.87	**9.55**	9.90
High-Hispanic	**9.89**	9.77	**9.66**	9.91
Low Income	9.82	**9.83**	9.59	9.92
Rural Provider	9.81	9.84	9.53	9.93
Bolded/shaded comparisons are significant at p<0.05.				

Appendix Chapter 12: Skilled Nursing Facilities

Detailed Methodology

This analysis focused on the SNF 30 –Day All Cause, Unplanned Hospital Readmission Measure (NQF 2510). The measure specifications focus on hospital readmissions that occur during the start of SNF care plus 30 days. The 30 day risk window for the re-hospitalization starts on the discharge date of the prior proximal hospitalization. The measure uses a 12 month observation period and this analysis used FY 2014 Medicare claims data. All SNF stays with an admission date within the observation window are included as a SNF anchor event if they do not meet the exclusion criteria specified in the measure. The SNF anchor event provider billing codes include skilled nursing facilities and swing-bed facilities per the measure specifications.

Inpatient Hospital and SNF Stays

Inpatient Provider codes: *xx0001-xx0879 (Inpatient Prospective Payment (IPPS)), xx1300-xx1399 (Critical Access Hospital (CAH)), xx4000-xx4099 (inpatient psychiatric hospitals (IPF)).*

SNF and Swing Bed Provider codes: *xx5000-xx6499 (skilled nursing facilities), xxUxxx, xxWxxx, xxYxxx and xxZxxx (swing-bed facilities).*

Inpatient claims and SNF claims were collapsed into stays separately, but using the same methodology:

1) Claims with the same beneficiary ID, admission date, and provider were considered one stay. All information was taken from the claim that had the latest discharge date (or in the case where none of the claims had discharge date, the claim with the latest through date), except for payment information, procedure codes, diagnosis codes, and revenue center codes, which were summed across all claims that were considered part of one stay.

2) After step 1 was completed, “chain stays” were further combined into one stay. “Chain stays” occurred when a beneficiary was discharged and then readmitted on the same day to the same provider (for Inpatient, also had to have the same principle diagnosis). The information from the first stay in a chain was kept, with discharge date and discharge status code taken from the last stay in a chain. Payment information, procedure codes, diagnosis codes, and revenue center codes were summed across all claims in a chain of stays.

After inpatient and SNF stays were built from claims, additional exclusions were applied. Stays were excluded if:

1) The stay’s Medicare payment amount was not greater than 0.
2) If the stay’s length of stay (calculated in nights) was not greater than 0.
3) If the stay had one of these provider state codes: (missing, 54, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 97, 98, 99)

The inpatient and SNF stays were then combined into one file, sorted by beneficiary ID, admission date, and discharge date to determine if there were any overlaps. For each beneficiary, any stays that overlapped, either in the same setting or across settings, were excluded. The exception to this rule was when the overlap occurred because an inpatient stay (defined as IPPS, CAH, IPF) had an admission date in middle of a SNF stay. This inpatient stay is considered "embedded" in the SNF stay. Both the SNF and inpatient stays are kept, and the SNF discharge date is reset to the inpatient admission date. The process of resetting the SNF discharge date occurs after checking for overlap with other stays.

Exclusions

Exclusions based on prior acute admission

- **SNF stays that do not have an acute inpatient admission 1 day before SNF admission.** Rationale: SNF patients with a gap between the acute admission and SNF have clinically different risk for readmission since they are admitted to a SNF later in the 30 day risk window.

- **Prior acute hospitalization was for non-surgical treatment of cancer.** Rationale: Patients with cancer diagnoses follow a different trajectory and high mortality rates. See Table 12 XX

- **Prior acute stay was for rehabilitation care and fitting of prostheses and adjustment devices.** Rationale: Admissions for rehabilitation care typically do not occur in an acute setting.

Source: *AHRQ Diagnosis CCS 254*

Exclusions based on SNF stay characteristics

- **The patient had a post-acute care admission (IRF or LTCH) between the prior acute hospitalization discharged and SNF admission, or after the SNF discharge, within the 30 day observation window.** An admission to an acute care hospital (IPPS or CAH), either planned or unplanned, closes the observation window, so any IRF or LTCH stay that occurs within 30 days of the prior proximal hospitalization discharge, but after a readmission, is not counted as an intervening stay. The SNF admission is included in the denominator.

Source: *Provider numbers ending in 3025-3099 for IRF, or 2000-2299 for LTCH using SNF from date as reference point*

- **Patients with multiple SNF admissions during the observation window.** An admission to an acute care hospital (IPPS and CAH), either planned or unplanned, closes the observation window, so any additional SNF stay that occurs within 30 days of the prior proximal hospitalization discharge, but after a readmission, is not counted as multiple SNF stays. The original SNF admission is still included in the denominator.
- **SNF anchor event resulted in discharge against medical advice.**

Source: *status code =07*

Exclusions based on patient characteristics

- **Patients who are not enrolled in FFS Medicare from 1 year prior to the discharge date of prior acute hospitalization through 30 days after the discharge date of prior acute hospitalization. Patients who are enrolled in Medicare Advantage at any point during this time period are also excluded.**

Source: *EDB information to determine beneficiary enrollment*

Unplanned Readmission

An admission to an acute care hospital (IPPS and CAH provider numbers ending in 0001-0879 and 1300-1399) in the 30 days following the discharge date of the prior acute admission is counted as an unplanned readmission unless:

- **The readmission stay has diagnosis or procedure codes (categorized into CCS) that are included in the list of frequently planned procedures.** The AHRQ CCS codes for planned and potentially planned readmissions are the same ones used in the Hospital-Wide All-Cause Unplanned Readmission Measure.

Source: *See Table 12XX*

A planned readmission ends the observation period (i.e. no readmissions after planned readmission).

Appendix Table 12.1: SNF Measure Population

Population Breakdown For SNF				
	Observation Period is FY 2014			
Population Exclusion steps		**Size**		
			#	**%**
Initial population: All SNF stays within the observation window			2,442,837	100%
1	Discharge was against medical advice	-	11,338	0.5%
2	Potential anchor stays without prior proximal stay within 1 day prior	-	384,596	15.7%
3	Potential anchor stays with other PAC stays in the 30-day window	-	105,095	4.3%
4	Patient was not continuously enrolled in Part A FFS	-	194,096	7.9%
Population: Potential anchor stays		=	1,747,712	100%
5	Prior acute stay was for rehabilitation care and fitting of prostheses and adjustment devices	-	1,520	0.1%
6	Prior acute stay was for non-surgical treatment for cancer	-	20,471	1.2%
Population: Anchor stays (Denominator)		**=**	**1,725,721**	**100%**
7	Anchor stays without readmission	-	1,393,657	80.8%
8	Readmission is planned	-	38,963	2.3%
Population: Anchor stays with unplanned readmission (Numerator)		**=**	**293,101**	**17.0%**
*** The 30-day risk window for readmission starts from the discharge date of the prior proximal stay.**				

Measures of Social Risk and Related Factors

Multiple measures of social risk and related factors were examined for their association with performance on the readmission measure. Each measure of social risk and related factors was constructed as a dichotomous variable, with "1" meaning the beneficiary had that social risk measure (e.g. resided in a rural area) and "0" indicating the beneficiary did not experience that measure of social risk. Measures derived from the census data were coded a "1" if the beneficiary resided in a ZCTA that

was in the most at risk quintile of ZCTAs for the social risk factor being measured (e.g., the ZCTA was in the lowest quintile for median income).

Appendix Table 12.2 Measures of Social Risk and Related Factors – Patient Level

Social Risk and Related Factors Category	Beneficiary-level variable	Source
Poverty (dual eligibility / low-income subsidy)	Patient-level indicator of whether the beneficiary is eligible for both Medicare and Medicaid.	CMS – Common Medicare Enrollment (CME)
Poverty (ZCTA-level income)	Patient-level indicator of ZCTA-level income	US Census Bureau
Race/ethnicity: black versus non-black	Patient-level RTI-race indicator of being black	RTI race recode
Race/ethnicity: Hispanic versus non-Hispanic	Patient-level RTI-race indicator of being Hispanic	RTI race recode
Rurality	Patient-level indicator of whether, at the time of the prior proximal stay admission, the patient is from a non- core-based statistical area	CMS- CASPER data
Disability	Patient-level indicator of whether his/her original reason for Medicare Entitlement was Disability	CMS – Enrollment Database

In the beneficiary-level analyses described below, models with (1) each social risk measure as the only social risk predictor and (2) all six social risk measures simultaneously were considered. Risk-mix adjustment was also included in the models as appropriate for individual measures.

A variable was created to define SNFs with high proportion of socially at-risk patients. A SNF serving a high proportion of patients at high social risk was defined as a SNF among the top 20% with the highest share of beneficiaries with the specified social risk variable. Acumen LLC sorted all SNFs by share of the high risk variable and identified SNFs in the top 20%.

Appendix Table 12.3 Measures of Social Risk and Related Factors – Provider Level

Social Risk and Related Factors Category	Provider-level variable
Poverty (dual eligibility / low-income subsidy)	SNF is among the top 20% with the highest share of patients with dual eligibility flag.
Poverty (ZCTA-level income)	SNF is among the top 20% with the highest share of patients with the ZCTA-level income flag.
Race/ethnicity: black versus non-black	SNF is among the top 20% with the highest share of patients with the Black race flag.
Race/ethnicity: Hispanic versus non-Hispanic	SNF is among the top 20% with the highest share of patients with the Hispanic race flag.

Rurality	SNF is located in a rural area.
Disability	SNF is among the top 20% with the highest share of patients with the Disability flag.

Association between Beneficiary-Level Social Risk and Performance

Acumen LLC performed a set of regression analyses using beneficiary-level data with social risk (SR in models below) factors as the main predictors of interest, and performance on the readmission measure as the main outcome. Trends in the odds of SNF 30-day all-cause readmissions associated with beneficiary and provider social risk factors were explored using logistic regression analysis on all denominator SNF stays. Generalized estimating equations (GEE) models were used to examine trends across SNFs, while still accounting for within-provider correlation. Random effect (RE) models using SNF-specific random intercepts were used to examine trends within SNFs.

Model 1: Patient level Effect - Odds of SNF readmission associated with beneficiary risk factors

- GEE model: SNF readmission= Beneficiary social risk factors, *Logistic regression with generalized estimating equation using independent correlation matrix*
- Model (without risk-adjustment): SNF readmission=Beneficiary social risk factors, *Logistic regression with SNF-specific random intercepts*
- RE Model (with risk-adjustment): SNF readmission= Beneficiary social risk factors + CMS risk-adjustment variables, *Logistic regression with SNF-specific random intercepts.*
- Multi-variable RE risk-adjusted: SNF readmission= All social risk factors + CMS risk-adjustment variables, *Logistic regression with SNF-specific random intercept*

Model 2: Provider level Effect – Odds of SNF readmission associated with SNFs serving a high proportion of high risk patients

- RE (without risk-adjustment): SNF readmission= Provider social risk factor, *Logistic regression with SNF-specific random intercepts*
- RE (with risk-adjustment): SNF readmission= Provider social risk factor + CMS risk-adjustment variables, *Logistic regression with SNF-specific random intercepts*

Model 3: Relative Contribution of Patient versus Provider Level Factors

The relationship between SNF readmissions and beneficiary SES factors when the factors are included in the risk-adjustment model separately, and together in the same model, is examined.

- Single-variable RE: SNF readmission (with risk-adjustment) = Beneficiary social risk factor or Provider social risk factor + CMS risk adjustment variables, *Logistic regression with SNF-specific random intercept*
- Multi-variable RE SNF readmission (with risk-adjustment) = All social risk factors + CMS risk-adjustment variables, *Logistic regression with SNF-specific random intercept*

Risk Adjustment Variables

The readmission rate is considered "risk adjusted" if the variables in table 12.4 are included in the regression model:

Appendix Table 12.4: Risk-adjustment variables

Variables	Data Sources	Definition
Age/sex categories (indicator variables)	Enrollment Database	Indicator variable for each age-sex group (reference is female 65-69)
Original reason for Medicare entitlement	Enrollment Database	Indicator for disability as original reason for Medicare entitlement
ESRD	Enrollment Database	Indicator for ESRD status
10 surgery categories	IP Claims	Indicator for each surgical group based on CCS of ICD-9 procedure codes from prior acute stay
72 comorbidities	IP Claims	Indicator for each comorbidity HCC grouping, based on all diagnosis codes from one year prior and all secondary diagnosis codes for prior acute stay
Count of HCCs, if 2 or more	IP Claims	Count if number of HCCs is greater than 2, Square of count
198 primary conditions - Principal diagnosis	IP Claims	Indicator for each CCS grouping, using AHRQ's single-level CCS
Number of acute care hospitalizations in 365 days prior to the proximal hospitalization	IP Claims	Categorical variable for number of stays (reference is 0 hospitalization)
LOS during prior proximal hospitalization	IP Claims	Categorical variable for length of stay (reference is 1-3 days, count in nights)
ICU during prior proximal hospitalization	IP Claims, rev center codes	Indicator for at least one day in ICU

Hierarchical logistic regression

Acumen LLC used a hierarchical logistic model for risk adjustment as specified for the measure. It models the log-odds of unplanned readmissions (within 30 days of SNF discharge), using risk adjustment variables as predictors, and facility-specific intercepts. During certain phases of this analysis, patient SES factors and hospital characteristics (structural and SES) will be included in the risk adjustment model, which means they are added as predictors:

$$\widehat{readmission}_1 = \hat{\alpha}_0 + (\hat{\beta}_1 SES) + \hat{\beta}_2 risk_{vars} + (\hat{\beta}_3 HC) + \hat{\delta} SNF_{id} \quad \text{(Stay level)}$$

The facility-specific intercepts ($\hat{\delta} SNF_{id}$) account for within facility correlation of readmission risk. Patient stays include an indicator for which SNF they are discharged from, and the facility effects are

measured as a positive or negative shift in the intercept term. It will be negative for a better-than-average facility, positive for a worse-than-average facility, and close to zero for an average facility.

Readmission Ratio (predicted/expected)

The **numerator**, also called the predicted readmissions, uses the hierarchical model, using full national data of SNF stays and unplanned readmissions. The facility-specific numerator is then calculated by summing all the predicted readmission rates of the patient stays at that facility, and then adding the facility's effect term. This value reflects the predicted number of readmissions for a SNF based on that particular SNF's performance and patient mix:

$$\hat{R}_{Nj} = \sum_j \widehat{readmission}_1 \text{ (SNF level – for SNF j)}$$

The **denominator**, also referred to as the expected readmissions, is the number of readmission that would be expected at the average SNF given the patient mix of the provider of interest. The same hierarchical logistic model that was used to calculate the numerator is used for the denominator. The predicted readmission rate for each patient stay is also added together when calculating the denominator, however, here the facility effect is zero since that is the average facility effect:

$$\widehat{readmission}_2 = \widehat{readmission}_1 - \hat{\delta}SNF_{id} \text{ (Stay level)}$$

$$\hat{R}_{Dj} = \sum_j \widehat{readmission}_2 \text{ (SNF level – for SNF j)}$$

The denominator is then the same value as the numerator, but without the facility effect ($\hat{\delta}SNF_{id}$).

Risk standardized readmission rate

The Risk standardized readmission rate (RSRR) is the national mean SNF readmission rate for all SNF stays multiplied by the predicted readmission/expected readmission ratio. The RSRR is used in Figures 12.1 and 12.2.

Additional Measure Documentation

Appendix Table 12.5 -Cancer discharge condition categories excluded from the measure (Medicare FFS data, 2011)

AHRQ CCS	Description	Number of Admissions
42	Secondary malignancies	9,638
19	Cancer of bronchus; lung	5,941
44	Neoplasms of unspecified nature or uncertain behavior	2,100
45	Maintenance chemotherapy; radiotherapy	1,953
38	Non-Hodgkin`s lymphoma	1,837
17	Cancer of pancreas	1,380
14	Cancer of colon	1,324
39	Leukemias	1,309

40	Multiple myeloma	1,258
35	Cancer of brain and nervous system	1,200
11	Cancer of head and neck	839
16	Cancer of liver and intrahepatic bile duct	686
15	Cancer of rectum and anus	646
13	Cancer of stomach	599
12	Cancer of esophagus	567
18	Cancer of other GI organs; peritoneum	554
29	Cancer of prostate	530
24	Cancer of breast	528
27	Cancer of ovary	415
43	Malignant neoplasm without specification of site	396
33	Cancer of kidney and renal pelvis	385
32	Cancer of bladder	366
25	Cancer of uterus	267
21	Cancer of bone and connective tissue	196
23	Other non-epithelial cancer of skin	147
41	Cancer; other and unspecified primary	145
28	Cancer of other female genital organs	95
26	Cancer of cervix	94
37	Hodgkin`s disease	74
20	Cancer; other respiratory and intrathoracic	63
36	Cancer of thyroid	49
34	Cancer of other urinary organs	46
22	Melanomas of skin	43
31	Cancer of other male genital organs	19
30	Cancer of testis	2
	Total	35,691

Source: RTI Analysis of Medicare Claims (output: :readmit139_cancers_excl_2011.xls)

Appendix Table 12.6: List of codes for planned and unplanned readmissions

A. Procedure categories that are always planned regardless of diagnosis procedure

AHRQ CCS Procedures	Name
64	Bone marrow transplant
105	Kidney transplant
134	Cesarean section
135	Forceps; vacuum; and breech delivery

176	Other organ transplantation

B. Diagnosis categories that are always planned regardless of procedure

AHRQ CCS Diagnoses	Name
45	Maintenance chemotherapy
194	Forceps delivery
196	Normal pregnancy and/or delivery
254	Rehabilitation

C. HWR planned procedures

AHRQ CCS Procedures	Name
3	Laminectomy; excision intervertebral disc
5	Insertion of catheter or spinal stimulator and injection into spinal
9	Other OR therapeutic nervous system procedures
10	Thyroidectomy; partial or complete
12	Other therapeutic endocrine procedures
33	Other OR therapeutic procedures on nose; mouth and pharynx
36	Lobectomy or pneumonectomy
38	Other diagnostic procedures on lung and bronchus
40	Other diagnostic procedures of respiratory tract and mediastinum
43	Heart valve procedures
44	Coronary artery bypass graft (CABG)
45	Percutaneous transluminal coronary angioplasty (PTCA)
47	Diagnostic cardiac catheterization; coronary arteriography
48	Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator
49	Other OR heart procedures
51	Endarterectomy; vessel of head and neck
52	Aortic resection; replacement or anastomosis
53	Varicose vein stripping; lower limb
55	Peripheral vascular bypass
56	Other vascular bypass and shunt; not heart
59	Other OR procedures on vessels of head and neck
62	Other diagnostic cardiovascular procedures
66	Procedures on spleen
67	Other therapeutic procedures; hemic and lymphatic system

74	Gastrectomy; partial and total
78	Colorectal resection
79	Local excision of large intestine lesion (not endoscopic)
84	Cholecystectomy and common duct exploration
85	Inguinal and femoral hernia repair
86	Other hernia repair
99	Other OR gastrointestinal therapeutic procedures
104	Nephrectomy; partial or complete
106	Genitourinary incontinence procedures
107	Extracorporeal lithotripsy; urinary
109	Procedures on the urethra
112	Other OR therapeutic procedures of urinary tract
113	Transurethral resection of prostate (TURP)
114	Open prostatectomy
119	Oophorectomy; unilateral and bilateral
120	Other operations on ovary
124	Hysterectomy; abdominal and vaginal
129	Repair of cystocele and rectocele; obliteration of vaginal vault
132	Other OR therapeutic procedures; female organs
142	Partial excision bone
152	Arthroplasty knee
153	Hip replacement; total and partial
154	Arthroplasty other than hip or knee
157	Amputation of lower extremity
158	Spinal fusion
159	Other diagnostic procedures on musculoskeletal system
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
169	Debridement of wound; infection or burn
170	Excision of skin lesion
172	Skin graft
211	Therapeutic radiology for cancer treatment
224	Cancer chemotherapy
ICD-9 Codes	**Description**
30.1, 30.29, 30.3, 30.4, 31.74, 34.6	Laryngectomy, revision of tracheostomy, scarification of pleura (from Proc CCS 42- Other OR Rx procedures on respiratory system and mediastinum)
38.18	Endarterectomy leg vessel (from Proc CCS 60- Embolectomy and endarterectomy of lower limbs)
55.03, 55.04	Percutaneous nephrostomy with and without fragmentation (from Proc CCS 103- Nephrotomy and nephrostomy)

94.26, 94.27	Electroshock therapy (from Proc CCS 218- Psychological and psychiatric evaluation and therapy)

Note: From the February 2013 Version of the HWR Planned Readmission Algorithm

D. HWR discharge condition categories that disqualify a readmission from being considered planned

Diagnosis CCS	Description
1	Tuberculosis
2	Septicemia (except in labor)
3	Bacterial infection; unspecified site
4	Mycoses
5	HIV infection
7	Viral infection
8	Other infections; including parasitic
9	Sexually transmitted infections (not HIV or hepatitis)
54	Gout and other crystal arthropathies
55	Fluid and electrolyte disorders
60	Acute posthemorrhagic anemia
61	Sickle cell anemia
63	Diseases of white blood cells
76	Meningitis (except that caused by tuberculosis or sexually transmitted disease)
77	Encephalitis (except that caused by tuberculosis or sexually transmitted disease)
78	Other CNS infection and poliomyelitis
82	Paralysis
83	Epilepsy; convulsions
84	Headache; including migraine
85	Coma; stupor; and brain damage
87	Retinal detachments; defects; vascular occlusion; and retinopathy
89	Blindness and vision defects
90	Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)
91	Other eye disorders
92	Otitis media and related conditions
93	Conditions associated with dizziness or vertigo
100	Acute myocardial infarction (with the exception of ICD-9 codes 410.x2)
102	Nonspecific chest pain
104	Other and ill-defined heart disease
107	Cardiac arrest and ventricular fibrillation

109	Acute cerebrovascular disease
112	Transient cerebral ischemia
116	Aortic and peripheral arterial embolism or thrombosis
118	Phlebitis; thrombophlebitis and thromboembolism
120	Hemorrhoids
122	Pneumonia (except that caused by TB or sexually transmitted disease)
123	Influenza
124	Acute and chronic tonsillitis
125	Acute bronchitis
126	Other upper respiratory infections
127	Chronic obstructive pulmonary disease and bronchiectasis
128	Asthma
129	Aspiration pneumonitis; food/vomitus
130	Pleurisy; pneumothorax; pulmonary collapse
131	Respiratory failure; insufficiency; arrest (adult)
135	Intestinal infection
137	Diseases of mouth; excluding dental
139	Gastroduodenal ulcer (except hemorrhage)
140	Gastritis and duodenitis
142	Appendicitis and other appendiceal conditions
145	Intestinal obstruction without hernia
146	Diverticulosis and diverticulitis
148	Peritonitis and intestinal abscess
153	Gastrointestinal hemorrhage
154	Noninfectious gastroenteritis
157	Acute and unspecified renal failure
159	Urinary tract infections
165	Inflammatory conditions of male genital organs
168	Inflammatory diseases of female pelvic organs
169	Debridement of wound; infection or burn
172	Ovarian cyst
197	Skin and subcutaneous tissue infections
198	Other inflammatory condition of skin
225	Joint disorders and dislocations; trauma-related
226	Fracture of neck of femur (hip)
227	Spinal cord injury
228	Skull and face fractures

229	Fracture of upper limb
230	Fracture of lower limb
232	Sprains and strains
233	Intracranial injury
234	Crushing injury or internal injury
235	Open wounds of head; neck; and trunk
237	Complication of device; implant or graft
238	Complications of surgical procedures or medical care
239	Superficial injury; contusion
240	Burns
241	Poisoning by psychotropic agents
242	Poisoning by other medications and drugs
243	Poisoning by nonmedicinal substances
244	Other injuries and conditions due to external causes
245	Syncope
246	Fever of unknown origin
247	Lymphadenitis
249	Shock
250	Nausea and vomiting
251	Abdominal pain
252	Malaise and fatigue
253	Allergic reactions
259	Residual codes; unclassified
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
653	Delirium, dementia, and amnestic and other cognitive disorders
656	Impulse control disorders, NEC
658	Personality disorders
660	Alcohol-related disorders
661	Substance-related disorders
662	Suicide and intentional self-inflicted injury
663	Screening and history of mental health and substance abuse codes
670	Miscellaneous disorders
ICD-9 Codes	**Description**
Acute ICD-9 codes within Dx CCS 97: Peri-; endo-; and myocarditis; cardiomyopathy	
03282	Diphtheritic myocarditis

03640	Meningococcal carditis nos
03641	Meningococcal pericarditis
03642	Meningococcal endocarditis
03643	Meningococcal myocarditis
07420	Coxsackie carditis nos
07421	Coxsackie pericarditis
07422	Coxsackie endocarditis
07423	Coxsackie myocarditis
11281	Candidal endocarditis
11503	Histoplasma capsulatum pericarditis
11504	Histoplasma capsulatum endocarditis
11513	Histoplasma duboisii pericarditis
11514	Histoplasma duboisii endocarditis
11593	Histoplasmosis pericarditis
11594	Histoplasmosis endocarditis
1303	Toxoplasma myocarditis
3910	Acute rheumatic pericarditis
3911	Acute rheumatic endocarditis
3912	Acute rheumatic myocarditis
3918	Acute rheumatic heart disease nec
3919	Acute rheumatic heart disease nos
3920	Rheumatic chorea w heart involvement
3980	Rheumatic myocarditis
39890	Rheumatic heart disease nos
39899	Rheumatic heart disease nec
4200	Acute pericarditis in other disease
42090	Acute pericarditis nos
42091	Acute idiopath pericarditis
42099	Acute pericarditis nec
4210	Acute/subacute bacterial endocarditis
4211	Acute endocarditis in other diseases
4219	Acute/subacute endocarditis nos
4220	Acute myocarditis in other diseases
42290	Acute myocarditis nos
42291	Idiopathic myocarditis
42292	Septic myocarditis
42293	Toxic myocarditis

42299	Acute myocarditis nec
4230	Hemopericardium
4231	Adhesive pericarditis
4232	Constrictive pericarditis
4233	Cardiac tamponade
4290	Myocarditis nos
Acute ICD-9 codes within Dx CCS 105: Conduction disorders	
4260	Atrioventricular block complete
42610	Atrioventricular block nos
42611	Atrioventricular block-1st degree
42612	Atrioventricular block-mobitz ii
42613	Atrioventricular block-2nd degree nec
4262	Left bundle branch hemiblock
4263	Left bundle branch block nec
4264	Right bundle branch block
42650	Bundle branch block nos
42651	Right bundle branch block/left posterior fascicular block
42652	Right bundle branch block/left ant fascicular block
42653	Bilateral bundle branch block nec
42654	Trifascicular block
4266	Other heart block
4267	Anomalous atrioventricular excitation
42681	Lown-ganong-levine syndrome
42682	Long qt syndrome
4269	Conduction disorder nos
Acute ICD-9 codes within Dx CCS 106: Dysrhythmia	
4272	Paroxysmal tachycardia nos
7850	Tachycardia nos
42789	Cardiac dysrhythmias nec
4279	Cardiac dysrhythmia nos
42769	Premature beats nec
Acute ICD-9 codes within Dx CCS 108: Congestive heart failure; nonhypertensive	
39891	Rheumatic heart failure
4280	Congestive heart failure
4281	Left heart failure
42820	Unspecified systolic heart failure
42821	Acute systolic heart failure

42823	Acute on chronic systolic heart failure
42830	Unspecified diastolic heart failure
42831	Acute diastolic heart failure
42833	Acute on chronic diastolic heart failure
42840	Unpec combined syst & dias heart failure
42841	Acute combined systolic & diastolic heart failure
42843	Acute on chronic combined systolic & diastolic heart failure
4289	Heart failure nos

Note: From the February 2013 Version of the HWR Planned Readmission Algorithm

Appendix Chapter 13: Home Health Agencies

Detailed Methodology

This analysis focused on two measures: 1) readmission during the first 30 days of HHA Care (NQF 2380) and 2) ED use without readmission during the first 30 days of HHA care (NQF 2505). The readmission and ED use without readmission measure specifications focus on hospital readmissions that occur during the start of HHA care plus 30 days. The measure applies to patients who had a hospitalization in the 5 days before the start of their home health stay and were re-admitted to a hospital during the 30 days following the start of the home health stay. Medicare home health is paid under a 60-day episode, unless there are four or fewer visits provided. This measure focuses on the first 30 days of the home health stay. While Medicare home health is covered for eligible beneficiaries who received prior hospital care or are from the community (i.e., those without a prior hospital stay), these measures only apply to those hospital-initiated Medicare home health users with a prior hospital stay meeting the measure criteria. The measures use three years of data for performance measurement. The observation period for this analysis is FYs 2012-2014.

Hospital and Home Health Stays

Hospital and home health stays were constructed using the home health re-hospitalization measures technical documentation and risk adjustment report found at:

https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HomeHealthQualityInits/HHQIQualityMeasures.html

Home Health Stays

Home Health Agency Provider Codes: *(xx7000-xx9799, xx3100-xx3199*)

Home health stays that have from dates within the observation window or the 120 days prior to the start of the observation window are used to create home health stays using the following steps:

1) Sort claims by patient, then from date.
2) For each beneficiary, drop claims that have the same from date and through date, listing no visits, or no payment. If multiple claims have the same from date, keep only the claim with the most recent process date.
3) The HH stay start date is the "from" date from a beneficiary's first claim. Going through each beneficiary's claims (by from date), if the next claim's from date is within 60 days of the previous claim's through date, then it is considered part of the same stay. Any claim that has a from date more than 60 days after the previous claim's through date marks the beginning of a new HH stay for that beneficiary.

4) Make the stay end date equal to the through date on the last claim in the HH stay. To confirm that this process was done correctly- each HH stay start date should be more than 60 days after the previous HH stay's end date.
5) Exclude any stays that occur in the 120 days prior to the start of the observation period (to ensure that claims beginning during the observation period are in fact separated from previous home health claims by at least 60 days).

All HH stays that are created using the listed steps are HH anchor events unless they fall under any measure exclusion rules described below.

Exclusions based on acute stay

- **HH stays that do not have an acute inpatient hospitalization 5 days before the start of the HH stay. *Provider code:*** *Short term hospitals xx0001-xx0879 (*short-term acute care hospital*), xx0880-xx0899 (*reserved hospitals participating in ORD demonstration projects*), xx1300-xx1399 (critical access hospitals).*

- **Prior acute stay was for treatment of cancer.** Rationale: Patients with cancer diagnoses follow a different trajectory and high mortality rates.

Appendix Table 13.1: Cancer discharge condition categories excluded from the measure (Medicare FFS data, 2011)

AHRQ CCS	Description	Number of Admissions
42	Secondary malignancies	9,638
19	Cancer of bronchus; lung	5,941
44	Neoplasms of unspecified nature or uncertain behavior	2,100
45	Maintenance chemotherapy; radiotherapy	1,953
38	Non-Hodgkin`s lymphoma	1,837
17	Cancer of pancreas	1,380
14	Cancer of colon	1,324
39	Leukemias	1,309
40	Multiple myeloma	1,258
35	Cancer of brain and nervous system	1,200
11	Cancer of head and neck	839
16	Cancer of liver and intrahepatic bile duct	686
15	Cancer of rectum and anus	646
13	Cancer of stomach	599
12	Cancer of esophagus	567
18	Cancer of other GI organs; peritoneum	554
29	Cancer of prostate	530
24	Cancer of breast	528
27	Cancer of ovary	415
43	Malignant neoplasm without specification of site	396
33	Cancer of kidney and renal pelvis	385

32	Cancer of bladder	366
25	Cancer of uterus	267
21	Cancer of bone and connective tissue	196
23	Other non-epithelial cancer of skin	147
41	Cancer; other and unspecified primary	145
28	Cancer of other female genital organs	95
26	Cancer of cervix	94
37	Hodgkin`s disease	74
20	Cancer; other respiratory and intrathoracic	63
36	Cancer of thyroid	49
34	Cancer of other urinary organs	46
22	Melanomas of skin	43
31	Cancer of other male genital organs	19
30	Cancer of testis	2
	Total	35,691

- **Prior acute stay was for treatment of primary psychiatric diseases.**

Appendix Table 13.2: AHRQ Diagnosis CCS considered psychiatric disease include:

AHRQ CCS	Description
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
654	Developmental disorders
655	Disorders usually diagnosed in infancy, childhood, or adolescence
656	Impulse control disorders, NEC
657	Mood disorders
658	Personality disorders
659	Schizophrenia and other psychotic disorders
662	Suicide and intentional self-inflicted injury
670	Miscellaneous disorders

- **Prior acute stay was for rehabilitation care and fitting of prostheses and adjustment devices.** R

Source: *AHRQ Diagnosis CCS 254*

- **Prior acute stay resulted in discharged against medical advice.** ***Source:*** *status code=07*

Exclusions based on HH stay

- **Stay begins with low-utilization payment adjustment (LUPA).**

Source: *LUPAIND=L for first claim in stay*

- **HH stays where patient has services from multiple agencies in one stay.**

Source: *Provider on first claim is provider on all subsequent claims in one HH stay*

- **Stays missing a payment episode authorization string.** ***Source:*** *Non-missing AUTHRZTN*

Exclusions based on patient characteristics

- **Patient is not continuously enrolled in FFS for 6 months prior to their HH stay through 30/60 days after beginning HH stay. Patients who are enrolled in Medicare Advantage at any point during this time period are also excluded.**

Source: *From EDB calculate enrollment string using from_dt from HH anchor event as reference date*

- **Patient received intervening care between index hospital discharge and start of HH care.** This includes inpatient hospitals use, IRFs, LTCHs, SNFs, and ED use without hospitalization.

Source: *Look for same beneficiary in time period of interest, on IP and OP claims*

Outcomes of Interest- 1) Unplanned re-hospitalization, 2) Emergency Department use without re-hospitalization or 3) No acute care use (no event)

Unplanned re-hospitalization

An admission to an acute care hospital (**provider code:** ***0001-0879*** for short-term acute care hospitals, ***0880-0899*** for reserved hospitals participating in ORD demonstration projects, ***1300-1399*** for critical access hospitals) in the 30 days (or 60 under acute care hospitalization and ED Use without hospitalization measure) days following the start of a HH anchor event (from date in first claim of HH stay) is counted as an unplanned re-hospitalization, unless:

- **Re-hospitalization has diagnosis or procedure codes (categorized into CCS) that are included in the list of frequently planned procedures.** The AHRQ CCS codes for planned and potentially planned re-hospitalizations are the same as the ones used in the Hospital-Wide All-Cause Unplanned Readmission Measure.

Appendix Table 13.3: Procedure categories that are always planned regardless of diagnosis procedure

AHRQ CCS Procedures	Name
64	Bone marrow transplant
105	Kidney transplant
134	Cesarean section
135	Forceps; vacuum; and breech delivery
176	Other organ transplantation

Appendix Table 13.4: Diagnosis categories that are always planned regardless of procedure

AHRQ CCS Diagnoses	Name
45	Maintenance chemotherapy
194	Forceps delivery
196	Normal pregnancy and/or delivery
254	Rehabilitation

Appendix Table 13.5: HWR planned procedures

AHRQ CCS Procedures	Name
3	Laminectomy; excision intervertebral disc
5	Insertion of catheter or spinal stimulator and injection into spinal
9	Other OR therapeutic nervous system procedures
10	Thyroidectomy; partial or complete
12	Other therapeutic endocrine procedures
33	Other OR therapeutic procedures on nose; mouth and pharynx
36	Lobectomy or pneumonectomy
38	Other diagnostic procedures on lung and bronchus
40	Other diagnostic procedures of respiratory tract and mediastinum
43	Heart valve procedures
44	Coronary artery bypass graft (CABG)
45	Percutaneous transluminal coronary angioplasty (PTCA)
47	Diagnostic cardiac catheterization; coronary arteriography
48	Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator
49	Other OR heart procedures
51	Endarterectomy; vessel of head and neck
52	Aortic resection; replacement or anastomosis
53	Varicose vein stripping; lower limb
55	Peripheral vascular bypass
56	Other vascular bypass and shunt; not heart
59	Other OR procedures on vessels of head and neck
62	Other diagnostic cardiovascular procedures
66	Procedures on spleen
67	Other therapeutic procedures; hemic and lymphatic system
74	Gastrectomy; partial and total
78	Colorectal resection
79	Local excision of large intestine lesion (not endoscopic)

84	Cholecystectomy and common duct exploration
85	Inguinal and femoral hernia repair
86	Other hernia repair
99	Other OR gastrointestinal therapeutic procedures
104	Nephrectomy; partial or complete
106	Genitourinary incontinence procedures
107	Extracorporeal lithotripsy; urinary
109	Procedures on the urethra
112	Other OR therapeutic procedures of urinary tract
113	Transurethral resection of prostate (TURP)
114	Open prostatectomy
119	Oophorectomy; unilateral and bilateral
120	Other operations on ovary
124	Hysterectomy; abdominal and vaginal
129	Repair of cystocele and rectocele; obliteration of vaginal vault
132	Other OR therapeutic procedures; female organs
142	Partial excision bone
152	Arthroplasty knee
153	Hip replacement; total and partial
154	Arthroplasty other than hip or knee
157	Amputation of lower extremity
158	Spinal fusion
159	Other diagnostic procedures on musculoskeletal system
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
169	Debridement of wound; infection or burn
170	Excision of skin lesion
172	Skin graft
211	Therapeutic radiology for cancer treatment
224	Cancer chemotherapy
ICD-9 Codes	**Description**
30.1, 30.29, 30.3, 30.4, 31.74, 34.6	Laryngectomy, revision of tracheostomy, scarification of pleura (from Proc CCS 42- Other OR Rx procedures on respiratory system and mediastinum)
38.18	Endarterectomy leg vessel (from Proc CCS 60- Embolectomy and endarterectomy of lower limbs)
55.03, 55.04	Percutaneous nephrostomy with and without fragmentation (from Proc CCS 103- Nephrotomy and nephrostomy)
94.26, 94.27	Electroshock therapy (from Proc CCS 218- Psychological and psychiatric evaluation and therapy)

Note: From the February 2013 Version of the HWR Planned Readmission Algorithm

Appendix Table 13.6: HWR discharge condition categories that disqualify a readmission from being considered planned

Diagnosis CCS	Description
1	Tuberculosis
2	Septicemia (except in labor)
3	Bacterial infection; unspecified site
4	Mycoses
5	HIV infection
7	Viral infection
8	Other infections; including parasitic
9	Sexually transmitted infections (not HIV or hepatitis)
54	Gout and other crystal arthropathies
55	Fluid and electrolyte disorders
60	Acute posthemorrhagic anemia
61	Sickle cell anemia
63	Diseases of white blood cells
76	Meningitis (except that caused by tuberculosis or sexually transmitted disease)
77	Encephalitis (except that caused by tuberculosis or sexually transmitted disease)
78	Other CNS infection and poliomyelitis
82	Paralysis
83	Epilepsy; convulsions
84	Headache; including migraine
85	Coma; stupor; and brain damage
87	Retinal detachments; defects; vascular occlusion; and retinopathy
89	Blindness and vision defects
90	Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)
91	Other eye disorders
92	Otitis media and related conditions
93	Conditions associated with dizziness or vertigo
100	Acute myocardial infarction (with the exception of ICD-9 codes 410.x2)
102	Nonspecific chest pain
104	Other and ill-defined heart disease
107	Cardiac arrest and ventricular fibrillation
109	Acute cerebrovascular disease
112	Transient cerebral ischemia
116	Aortic and peripheral arterial embolism or thrombosis

118	Phlebitis; thrombophlebitis and thromboembolism
120	Hemorrhoids
122	Pneumonia (except that caused by TB or sexually transmitted disease)
123	Influenza
124	Acute and chronic tonsillitis
125	Acute bronchitis
126	Other upper respiratory infections
127	Chronic obstructive pulmonary disease and bronchiectasis
128	Asthma
129	Aspiration pneumonitis; food/vomitus
130	Pleurisy; pneumothorax; pulmonary collapse
131	Respiratory failure; insufficiency; arrest (adult)
135	Intestinal infection
137	Diseases of mouth; excluding dental
139	Gastroduodenal ulcer (except hemorrhage)
140	Gastritis and duodenitis
142	Appendicitis and other appendiceal conditions
145	Intestinal obstruction without hernia
146	Diverticulosis and diverticulitis
148	Peritonitis and intestinal abscess
153	Gastrointestinal hemorrhage
154	Noninfectious gastroenteritis
157	Acute and unspecified renal failure
159	Urinary tract infections
165	Inflammatory conditions of male genital organs
168	Inflammatory diseases of female pelvic organs
169	Debridement of wound; infection or burn
172	Ovarian cyst
197	Skin and subcutaneous tissue infections
198	Other inflammatory condition of skin
225	Joint disorders and dislocations; trauma-related
226	Fracture of neck of femur (hip)
227	Spinal cord injury
228	Skull and face fractures
229	Fracture of upper limb
230	Fracture of lower limb
232	Sprains and strains

233	Intracranial injury
234	Crushing injury or internal injury
235	Open wounds of head; neck; and trunk
237	Complication of device; implant or graft
238	Complications of surgical procedures or medical care
239	Superficial injury; contusion
240	Burns
241	Poisoning by psychotropic agents
242	Poisoning by other medications and drugs
243	Poisoning by nonmedicinal substances
244	Other injuries and conditions due to external causes
245	Syncope
246	Fever of unknown origin
247	Lymphadenitis
249	Shock
250	Nausea and vomiting
251	Abdominal pain
252	Malaise and fatigue
253	Allergic reactions
259	Residual codes; unclassified
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
653	Delirium, dementia, and amnestic and other cognitive disorders
656	Impulse control disorders, NEC
658	Personality disorders
660	Alcohol-related disorders
661	Substance-related disorders
662	Suicide and intentional self-inflicted injury
663	Screening and history of mental health and substance abuse codes
670	Miscellaneous disorders
ICD-9 Codes	**Description**
Acute ICD-9 codes within Dx CCS 97: Peri-; endo-; and myocarditis; cardiomyopathy	
03282	Diphtheritic myocarditis
03640	Meningococcal carditis nos
03641	Meningococcal pericarditis
03642	Meningococcal endocarditis

03643	Meningococcal myocarditis
07420	Coxsackie carditis nos
07421	Coxsackie pericarditis
07422	Coxsackie endocarditis
07423	Coxsackie myocarditis
11281	Candidal endocarditis
11503	Histoplasma capsulatum pericarditis
11504	Histoplasma capsulatum endocarditis
11513	Histoplasma duboisii pericarditis
11514	Histoplasma duboisii endocarditis
11593	Histoplasmosis pericarditis
11594	Histoplasmosis endocarditis
1303	Toxoplasma myocarditis
3910	Acute rheumatic pericarditis
3911	Acute rheumatic endocarditis
3912	Acute rheumatic myocarditis
3918	Acute rheumatic heart disease nec
3919	Acute rheumatic heart disease nos
3920	Rheumatic chorea w heart involvement
3980	Rheumatic myocarditis
39890	Rheumatic heart disease nos
39899	Rheumatic heart disease nec
4200	Acute pericarditis in other disease
42090	Acute pericarditis nos
42091	Acute idiopath pericarditis
42099	Acute pericarditis nec
4210	Acute/subacute bacterial endocarditis
4211	Acute endocarditis in other diseases
4219	Acute/subacute endocarditis nos
4220	Acute myocarditis in other diseases
42290	Acute myocarditis nos
42291	Idiopathic myocarditis
42292	Septic myocarditis
42293	Toxic myocarditis
42299	Acute myocarditis nec
4230	Hemopericardium
4231	Adhesive pericarditis

4232	Constrictive pericarditis
4233	Cardiac tamponade
4290	Myocarditis nos
Acute ICD-9 codes within Dx CCS 105: Conduction disorders	
4260	Atrioventricular block complete
42610	Atrioventricular block nos
42611	Atrioventricular block-1st degree
42612	Atrioventricular block-mobitz ii
42613	Atrioventricular block-2nd degree nec
4262	Left bundle branch hemiblock
4263	Left bundle branch block nec
4264	Right bundle branch block
42650	Bundle branch block nos
42651	Right bundle branch block/left posterior fascicular block
42652	Right bundle branch block/left ant fascicular block
42653	Bilateral bundle branch block nec
42654	Trifascicular block
4266	Other heart block
4267	Anomalous atrioventricular excitation
42681	Lown-ganong-levine syndrome
42682	Long qt syndrome
4269	Conduction disorder nos
Acute ICD-9 codes within Dx CCS 106: Dysrhythmia	
4272	Paroxysmal tachycardia nos
7850	Tachycardia nos
42789	Cardiac dysrhythmias nec
4279	Cardiac dysrhythmia nos
42769	Premature beats nec
Acute ICD-9 codes within Dx CCS 108: Congestive heart failure; nonhypertensive	
39891	Rheumatic heart failure
4280	Congestive heart failure
4281	Left heart failure
42820	Unspecified systolic heart failure
42821	Acute systolic heart failure
42823	Acute on chronic systolic heart failure
42830	Unspecified diastolic heart failure
42831	Acute diastolic heart failure

42833	Acute on chronic diastolic heart failure
42840	Unpec combined syst & dias heart failure
42841	Acute combined systolic & diastolic heart failure
42843	Acute on chronic combined systolic & diastolic heart failure
4289	Heart failure nos

Note: From the February 2013 Version of the HWR Planned Readmission Algorithm

Appendix Table 13.7: RTI added AHRQ CCS single level procedure codes and ICD-9 procedure codes to Yale's planned readmission algorithm, for the post-acute care setting

AHRQ CCS Single Level Procedures Codes	Description	Comment
37	Diagnostic Bronchoscopy and Biopsy of Bronchus	
71	Gastrostomy: temporary and permanent	
82	Endoscopic retrograde cannulation of pancreases (ERCP)	
87	Laparoscopy (GI only)	
89	Exploratory Laparotomy	
160	Other therapeutic procedure on muscles and tendons	
164	Other OR therapeutic procedures on musculoskeletal system	
171	Suture of skin and subcutaneous tissue	
ICD-9 Procedure Codes	**Description**	**Comment**
Topic: Amputation of Lower Extremity		
83.82	Graft of muscle or fascia	
86.87	Fat graft of skin and subcutaneous tissue	Required, Diagnosis V58.41, encounter for planned postoperative wound closure
Topic: Amputation of Upper Extremity		
84.00	Upper limb amputation, not otherwise specified	
84.01	Amputation and disarticulation of finger	
84.02	Amputation and disarticulation of thumb	
84.03	Amputation through hand	
84.04	Disarticulation of wrist	
84.05	Amputation through forearm	
84.06	Disarticulation of elbow	
84.07	Amputation through humerus	

84.08	Disarticulation of shoulder	
84.09	Interthoracoscapular amputation	
Topic: Removal of Vascular Obstruction, Non-Coronary		
38.18	Endarterectomy, lower limb vessels	
38.08	Embolectomy, lower limb arteries	
39.50	Angioplasty or atherectomy of other non-coronary vessels	
00.55	Insertion of drug-eluting stent(s) of other peripheral vessel(s)	
00.60	Insertion of drug-eluting stent(s) of superficial femoral artery	
39.90	Insertion of non-drug-eluting peripheral (non-coronary) vessel stent(s)	
Topic: Colon and Rectal Procedures, Selected		
46.85	Dilation of intestine (includes endosopic approach)	
96.08	Insertion of naso-intestinal tube (includes for decompression)	
96.09	Insertion of rectal tube	
46.50	Closure of intestinal stoma, not otherwise specified	Required, Diagnosis code V55.2, attention to ileostomy, and V55.3, attention to colostomy
46.51	Closure of stoma of small intestine	Required, Diagnosis code V55.2, attention to ileostomy, and V55.3, attention to colostomy
46.52	Closure of stoma of large intestine	Required, Diagnosis code V55.2, attention to ileostomy, and V55.3, attention to colostomy
46.86	Endoscopic insertion of colonic stent(s)	
46.87	Other insertion of colonic stent (s)	
Topic: Insertion of Feeding Tubes		
44.39	Other gastroenterostomy (GJ-tube)	
Topic: Routine Device Replacement		
86.06	Insertion of totally implanted infusion pump	
Topic: Routine Removal of Devices		
84.57	Removal of (cement) spacer (includes antibiotic impregnated spacer)	
97.41	Removal of thoracotomy tube or pleural cavity drain (non-incisional)	
02.43	Removal of ventricular shunt	
97.37	Removal of tracheostomy tube (non-incisional)	

01.27	removal of catheter(s) from cranial cavity or tissue	
86.05	Incision with removal of foreign body or device from skin and subcutaneous tissue	
02.95	Removal of skull tongs or halo traction device	
78.60-78.69	Removal of implanted devices from bone(includes internal and external fixation)	
80.00-80.09	Orthopedic implants arthrotomy for removal of prosthesis without replacement	This code became available in CY 2010
Topic: Pleurosclerosis		
34.6	Scarification of pleura	
34.92	Injection into thoracic cavity	
Topic: Colon and Rectal Procedures, Selected		
51.14	Other close (endoscopic) biopsy of biliary duct or sphincter of Oddi	
51.64	Endoscopic excision or destruction of lesion of biliary ducts or sphincter of Oddi	
51.84	Endoscopic dilation of ampulla and biliary duct	
51.85	Endoscopic sphincterotomy and papillotomy	
51.86	Endoscopic insertion of nasobiliary drainage tube	
51.87	Endoscopic insertion of stent (tube) into bile duct	
51.88	Endoscopic removal of stone(s)from biliary tract	
Topic: Fistula		
42.84	Repair of esophageal fistula, not elsewhere classified	
44.63	Closure of other gastric fistula (include gastrocolic, gastrojejunocolic fistula)	
46.72	Closure of fistula of duodenum	
46.74	Closure of fistula of small intestine, except duodenum (includes enterocutaneous)	
46.76	Closure of fistula of large intestine	
47.92	Closure of appendiceal fistula	
48.73	Closure of other rectal fistula	
48.93	Repair of perirectal fistula	
49.11	Anal fistulotomy	
49.12	Anal fistulectomy	
49.73	Closure of anal fistula	

19.9	Other repair of middle ear (includes closure of mastoid fistula	
20.93	Repair of oval and round windows (includes closure of fistula)	
21.82	Closure of nasal fistula	
31.62	Closure of fistula of larynx (includes laryngotracheal)	
31.73	Closure of other fistula of trachea (includes tracheoesophageal)	
33.42	Closure of bronchial fistula (includes bronchocutaneous, bronchoesophageal, bronchovisceral)	
34.73	Closure of other fistula of thorax (includes bronchopleural, bronchopleurocutaneous, bronchopleuromediastinal)	
34.83	Closure of fistula of diaphragm (includes thoracicoabdominal, thoracicogastric, thoracicointestinal)	
34.93	Repair of pleura (includes closure of unspecified pleural fistula)	
61.42	repair of scrotal fistula	
Topic: Tendon Repair (eye)		
15.7	Repair of injury of extraocular muscle (includes repair of tendon)	
Topic: Aneurysm		
39.51	Clipping of aneurysm	

A planned re-hospitalization (or hospitalization under 60-day measure) does not end the observation period (i.e. readmissions can happen after planned re-hospitalization). A re-hospitalization (or hospitalization under acute care hospitalization and ED Use without hospitalization measure) can be counted as a new prior acute stay if it meets all other criteria.

Emergency Department use without re-hospitalization

A HH anchor event is flagged for ED use without re-hospitalization if, within 30 days of the start of the HH anchor event (from date of first claim in the HH stay), the patient has any outpatient claims with ED revenue center codes (0450-0459, 0981). This is unless:

- **Within the 30 day window the patient also has an inpatient claim for admission to an acute care hospital.**

Source: *IP claim with provider numbers xx0001-xx0879 (Short-term acute-care hospitals), xx0880-xx0899 (hospitals participating in ORD demonstration projects), xx1300-xx1399 (critical access hospitals).*

No acute care use (no event)

Any HH anchor event that is not flagged for unplanned re-hospitalization or ED use without re-hospitalization is counted as "no acute care use (no event)."

Appendix Table 13.8: Measure Population

Population			FY 2012		FY 2013		FY 2014		Total	
Exclusion steps			#	%	#	%	#	%	#	%
Initial population: All HH stays within the observation window			3,328,333	100%	3,387,243	100%	3,306,496	100%	10,022,072	100%
Stage 1	1	No prior IP stay within 5 days of HH admission	2,254,965	67.75%	2,297,623	67.83%	2,260,830	68.38%	6,813,418	67.98%
	2	Not continuously enrolled in Part A and B	68,131	2.05%	69,009	2.04%	69,003	2.09%	206,143	2.06%
	3	LUPA on first claim	100,126	3.01%	102,182	3.02%	95,223	2.88%	297,531	2.97%
	4	Multiple HH agencies in the first 30 days in one stay	4,835	0.15%	4,712	0.14%	4,158	0.13%	13,705	0.14%
	Population: After preliminary Exclusions		900,276	27.05%	913,717	26.98%	877,282	26.53%	2,691,275	26.85%
Stage 2	5	Prior acute was for treatment of cancer	47,516	5.28%	46,049	5.04%	43,043	4.91%	136,608	5.08%
	6	Prior acute was for psychiatric disease	1,611	0.18%	1,427	0.16%	1,409	0.16%	4,447	0.17%
	7	Prior acute was for rehabilitation care and fitting of prostheses	2,487	0.28%	2,371	0.26%	2,284	0.26%	7,142	0.27%
	8	Prior acute ended in discharge against medical advice	1,070	0.12%	1,121	0.12%	1,080	0.12%	3,271	0.12%
	Population: After Prior Acute Exclusions		847,592	94.15%	862,749	94.42%	829,466	94.55%	2,539,807	94.37%
Stage 3	9	Stays with intervening IRF/LTCH/SNF/IPF between prior acute and HH stay	13,091	1.54%	12,634	1.46%	11,489	1.39%	37,214	1.47%
	10	Stays with intervening ED use between prior acute and HH stay	12,234	1.44%	12,636	1.46%	12,412	1.50%	37,282	1.47%
	11	HH stays with missing payment-episode authorization strings	368	0.04%	287	0.03%	269	0.03%	924	0.04%
	Population: Denominator		821,899	96.97%	837,192	97.04%	805,296	97.09%	2,464,387	97.03%
Stage 4	12	Anchor stays without rehospitalization or ED use	629,883	76.64%	643,732	76.89%	621,755	77.21%	1,895,370	76.91%
	13	Anchor stays with planned rehospitalization	8,744	1.06%	8,547	1.02%	7,631	0.95%	24,922	1.01%
	Population: Numerator		183,272	22.30%	184,913	22.09%	175,910	21.84%	544,095	22.08%
Outcome 1: Anchor stays with ED use but without unplanned rehospitalization			71,573	8.71%	75,251	8.99%	74,246	9.22%	221,070	8.97%
Outcome 2: Anchor stays with unplanned rehospitalization			111,699	13.59%	109,662	13.10%	101,664	12.62%	323,025	13.11%

Measures of Social Risk and Related factors

Multiple measures of social risk and related factors were examined for their association with performance on the readmission measure. Each measure of social risk and related factors was constructed as a dichotomous variable, with "1" meaning the beneficiary had that social risk measure (e.g. resided in a rural area) and "0" indicating the beneficiary did not experience that measure of social risk. Measures derived from the census data were coded a "1" if the beneficiary resided in a ZCTA that was in the most at risk quintile of ZCTAs for the social risk factor being measured (e.g., the ZCTA was in the lowest quintile for median income).

Appendix Table 13.9 Measures of Social Risk and Related Factors – Patient Level

Social Risk and Related Factors Category	Beneficiary-level variable	Source
Poverty (dual eligibility / low-income subsidy)	Patient-level indicator of whether the beneficiary is eligible for both Medicare and Medicaid.	CMS – Common Medicare Enrollment (CME)
Poverty (ZCTA-level income)	Patient-level indicator of ZCTA-level income	US Census Bureau
Race/ethnicity: black versus non-black	Patient-level RTI-race indicator of being black	RTI race recode
Race/ethnicity: Hispanic versus non-Hispanic	Patient-level RTI-race indicator of being Hispanic	RTI race recode
Rurality	Patient-level indicator of whether, at the time of the prior proximal stay admission, the patient is from a non- core-based statistical area	CMS- CASPER data
Disability	Patient-level indicator of whether his/her original reason for Medicare Entitlement was Disability	CMS – Enrollment Database

In the beneficiary-level analyses described below, models with (1) each social risk as the only social risk predictor and (2) all six social risk measures simultaneously were considered. Risk-mix adjustment was also included in the models as appropriate for individual measures.

Appendix Table 13.10 Measures of Social Risk and Related Factors – Provider Level

A variable was created to define HHAs with high proportion of socially at-risk patients. This definition differs from the SNF definition included in chapter 12 due to sample size issues. A HHA serving a high proportion of patients at high social risk was defined as a HHA which accounts for 20% of the initial measure population. Accumen LLC sorted all providers by the share of the social risk variable and identified HHAs which accounted for 20% of the initial measure population.

All HHAs that had at least one stay in the initial population were ranked based on their proportion of initial stays with each beneficiary risk factor. Acumen LLC determined a cut-off point so that all HHAs that had a proportion higher than the cut-off would collectively account for 20% of the initial stays. If a HHA had a proportion stays with a beneficiary risk factor that was greater than the cut-off, then it was flagged for the corresponding provider risk factor. This process was done for all initial stays in fiscal years 2012-2014.

Appendix Table 13.10: Social Risk Factors, Provider Level

Social Risk and Related Factors Category	Provider-level variable
Poverty (dual eligibility / low-income subsidy)	HHA has highest proportion of "Dual" initial stays in observation period, where all "High Dual" HHAs account for at least 20% of the initial stays
Poverty (ZCTA-level income)	HHA has highest proportion of "Low-Income" initial stays in observation period, where all "High Low-Income" HHAs account for at least 20% of the initial stays
Race/ethnicity: black versus non-black	HHA has highest proportion of "Black" initial stays in observation period, where all "High Black" HHAs account for at least 20% of the initial stays
Race/ethnicity: Hispanic versus non-Hispanic	HHA has highest proportion of "Hispanic" initial stays in observation period, where all "High Hispanic" HHAs account for at least 20% of the initial stays
Rurality	HHA has highest proportion of "Rural" initial stays in observation period, where all "High Rural" HHAs account for at least 20% of the initial stays
Disability	HHA has highest proportion of "Disabled" initial stays in observation period, where all "High Disabled" HHAs account for at least 20% of the initial stays

Association between Beneficiary-Level Social Risk and Performance

Acumen LLC performed a set of regression analyses using beneficiary-level data with social risk (SR in models below) factors as the main predictors of interest, and performance on the main outcomes. Trends in the odds of 30-day all-cause re-hospitalizations or ED use without re-hospitalizations associated with beneficiary and provider social risk factors were explored using logistic regression analysis on all denominator HHA stays. As specified for the measure, Acumen LLC uses a multinomial logistical framework which is applied to the model to provide three disjoint outcomes: Re-hospitalization, ED use without re-hospitalization or no event. To make comparisons, Acumen LLC calculated odds ratios to show the likelihood of each of the two outcomes versus the third (i.e., re-hospitalization/no outcome or ED use/no outcome). Generalized estimating equations (GEE) models were used to examine trends across HHAs, while still accounting for within-provider correlation. Random effect (RE) models using HHA-specific random intercepts were used to examine trends within HHAs.

Model 1: Patient level Effect - Outcomes -HHA readmission or ED use without readmission

- GEE: HHA outcome = Beneficiary social risk factor, *Multinomial logistic regression with generalized estimating equation using independent correlation matrix*
- RE (without risk-adjustment): HHA outcome = Beneficiary social risk factor, *Multinomial logistic regression with HHA-specific random intercepts*
- RE (with risk-adjustment): HHA outcome = Beneficiary social risk factor + CMS risk-adjustment variables, *Multinomial logistic regression with HHA-specific random intercepts.*
- Multi-variable RE (with risk-adjustment): HHA outcome = All beneficiary social risk factor + CMS risk-adjustment variables, *Multinomial logistic regression with HHA-specific random intercept*

Model 2: Provider level Effect – Odds of HHA readmission or ED use without readmission associated with HHAs serving a high proportion of high risk patients

- RE (without risk-adjustment): HHA outcome = Provider social risk factor, *Multinomial logistic regression with HHA-specific random intercepts*
- RE (with risk-adjustment): HHA outcome = Provider social risk factor + CMS risk-adjustment variables, *Multinomial logistic regression with HHA-specific random intercepts*

Model 3: Relative Contribution of Patient versus Provider Level Factors

The relationship between HHA readmissions or ED use without readmissions and beneficiary social risk factors when the factors are included in the risk-adjustment model separately, and together in the same model, is examined.

- Single-variable RE (with risk-adjustment): HHA outcome = Beneficiary social risk factor or Provider social risk factor + CMS risk adjustment variables, *Logistic regression with HHA-specific random intercept*
- Multi-variable RE (with risk-adjustment): HHA outcome= All beneficiary or All Provider social risk factors + CMS risk-adjustment variables, *Logistic regression with HHA-specific random intercept*

Risk-adjustment Variables for Home Health 30-day Re- hospitalization and ED use Measures

The outcome is considered "risk adjusted" if the variables are included in the regression model:

Appendix Table 13.11: Risk Adjustment Variables

Variables	Data Sources	Definition
Age/sex categories	Enrollment Database	Indicator variable for each age-sex group (reference is male 65-69)
Original reason for Medicare entitlement	Enrollment Database	4 Indicators (currently ESRD, originally ESRD, originally disabled female, originally disabled male)
Prior use in the 30 days prior to start of HH and the prior index	IP & SNF Claims	Indicator for SNF use, indicator for multiple IP admissions

hospitalization		
Care received within 30 days to 6 months prior to HH	IP & OP Claims	Indicators for single ER visit, multiple ER visits, and indicators for IP admissions split by cohort
LOS in prior short-term hospital stay	IP Claims	2 Indicators
Health status - CMS HCCs	IP & OP Claims	6 month look-back of diagnosis codes
Health status - DRG	IP Claims	DRG of prior acute hospitalization
Health status - ADL Scores	Claim Authorization String	OASIS based ADL scores 1-4 for 5 categories, ranging from 0-16
Interaction terms	IP & OP Claims	Interaction terms of comorbidity indicators (includes interaction with disability)