

Final Recommendation for Modifying the Maryland Hospital-Acquired Conditions Program for FY 2018

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This document contains staff recommendations for updating the Maryland Hospital-Acquired Conditions Program for FY 2018.

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LIST OF ABBREVIATIONS

CMMI	Center for Medicare and Medicaid Innovation
CMS	Centers for Medicare & Medicaid Services
CY	Calendar year
DRG	Diagnosis-related group
FFY	Federal fiscal year
FY	Fiscal year
HAC	Hospital-acquired condition
HSCRC	Health Services Cost Review Commission
MHAC	Maryland hospital-acquired condition
PPC	Potentially preventable complication
PSI	Patient safety indicator

INTRODUCTION

A hospital-acquired condition (HAC) occurs when a patient goes to the hospital for one condition but develops another condition during that hospital stay. The second condition—such as an adverse drug reaction or an infection at the site of a surgery—is referred to as hospital-acquired.¹ HACs can lead to 1) poor patient outcomes, including longer hospital stays, permanent harm, and death, and 2) increased costs.² Over the past decade, the Centers for Medicare & Medicaid Services (CMS) has implemented several programs to improve the quality of care for Medicare participants, including a program to reduce the frequency of HACs. Because of the state's long-standing Medicare waiver for its all-payer hospital rate-setting system, special considerations were given to Maryland hospitals, including exemption from the federal Medicare hospital quality programs, one of which is the HAC program. Instead, the Maryland Health Services Cost Review Commission (HSCRC or Commission) implements various Maryland-specific quality-based payment programs, which provide incentives for hospitals to improve their quality performance over time. The HSCRC implemented the Maryland Hospital-Acquired Conditions (MHAC) program in state fiscal year (FY) 2011.

Maryland entered into a new All-Payer Model agreement with the Center for Medicare and Medicaid Innovation (CMMI) on January 1, 2014. One of the requirements under this new agreement is for Maryland to reduce the incidence of HACs by 30 percent by 2018. In order to meet this target, the Commission approved several methodological changes to the program for FY 2016, which are discussed in further detail in the background section of this report. The Commission approved additional revisions to the methodology for FY 2017. The purpose of this report is to provide background information on the MHAC program and to make recommendations for the FY 2018 MHAC methodology and targets.

BACKGROUND

1. Federal HAC Programs

Medicare's system for the payment of inpatient hospital services is called the inpatient prospective payment system. Under this system, patients are assigned to a payment category called a diagnosis-related group (DRG), which is a method of categorizing costs so that Medicare can determine how much to pay for the hospital stay. DRGs are based on a patient's primary diagnosis and the presence of other conditions; patients with higher co-morbidities or complications are categorized into higher-paying DRGs.³ Historically, Medicare payments under this system were based on the volume of services. However, beginning in federal fiscal year (FFY) 2009, CMS stopped assigning patients to higher-paying DRGs if certain conditions were *not* present on the patient's admission, or, in other words, if the condition was acquired in the hospital and could have reasonably been prevented through the application of evidence-based

¹ Cassidy, A. (2015, August 6). Health Policy Brief: Medicare's Hospital-Acquired Condition Reduction Program. *Health Affairs*. Retrieved from http://www.healthaffairs.org/healthpolicybriefs/brief.php?brief_id=142.

² Ibid.

³ Ibid.

guidelines. CMS identified 11 conditions that are presumed to be acquired in the hospital if the diagnosis is not present on the patient's admission. CMS will not assign these patients to more expensive DRGs, and thus does not pay, for these HACs.⁴ This policy is referred to as the HAC (present on admission indicator) program.⁵ Since non-payment on a case-by-case basis affects only a small fraction of claims, the impact of this program was estimated to be very limited. The program resulted in \$21 million in savings in federal fiscal year (FFY) 2010.⁶ Maryland hospitals were exempt from the payment adjustments under this program.

CMS expanded the use of HACs in payment adjustments in FFY 2015 with a new program entitled the "Hospital-Acquired Condition Reduction Program" under authority of the Affordable Care Act. In this program, CMS ranks hospitals according to performance on a list of HAC quality measures and reduces Medicare payments to the hospitals in the lowest performing quartile. Since the HAC program began, the maximum penalty has been set at 1 percent of total DRG payments. The CMS HAC measures for FFY 2017 are listed in Appendix I of this report and include measures of patient safety developed by the Agency for Healthcare Research and Quality and measures of healthcare-associated infections developed by the Centers for Disease Control and Prevention.⁷ Prior to the new All-Payer Model Agreement, CMS required the HSCRC to submit an annual exemption request demonstrating that outcomes and cost savings of the Maryland-specific program met or exceeded those of the CMS federal program. Under Maryland's new All-Payer Model agreement, this requirement was replaced by the 30 percent HAC reduction goal, as well as a requirement to match the aggregate amount of revenue at risk in quality-based payment adjustments with the amount at risk in the Medicare programs.

2. Overview of the MHAC Program

As discussed in the introduction section of this report, Maryland is exempt from the federal HAC programs, and, instead, HSCRC has implemented the MHAC program since FY 2011. The MHAC program is based on a classification system developed by 3M called potentially preventable complications (PPCs). PPCs are defined as harmful events that develop after the patient is admitted to the hospital and may result from processes of care and treatment rather than from the natural progression of the underlying illness. Therefore, these events are considered potentially preventable. 3M developed 65 PPC measures that are identified through secondary diagnosis codes that are not present on the patient's admission. Examples of PPCs include accidental puncture/laceration during an invasive procedure or infections related to central venous catheters.

⁴ Ibid.

⁵ For more information on the federal HAC Present on Admission program, see

<https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/index.html>

⁶ CMS. (2012, December). Report to Congress: Assessing the Feasibility of Extending the Hospital Acquired Conditions (HAC) IPPS Payment Policy to Non-IPPS Settings. Retrieved from

<https://innovation.cms.gov/Files/x/HospAcquiredConditionsRTC.pdf>

⁷ For more information on the federal HAC Reduction program, see <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/HAC-Reduction-Program.html>.

The initial methodology for the MHAC program was in place until FY2016. This methodology estimated the percentage of inpatient revenue associated with an excess number of PPCs. The excess number of PPCs was estimated by comparing hospitals' observed PPC rate to a statewide average PPC rate given the diagnoses and severity of illness (or "case-mix") of the hospital's patient population. The marginal cost of each PPC was estimated using a statewide regression analysis. Those PPCs that are deemed to have measurement biases, or those with marginal associated costs that were not statistically significant, were excluded from the program. Next, the payment adjustment approach assessed penalties to hospitals that had higher PPC costs than the statewide average and granted rewards to hospitals with lower PPC costs than the statewide average. The payment adjustments were proportionate to a hospital's difference from the statewide average (this is referred to as continuous scaling). Rewards were adjusted to ensure that the final net impact of the scaling to the state was zero (i.e., revenue neutral). In general, the payment adjustments process resulted in fewer hospitals receiving penalties and consequently limited the amount of revenue available for the rewards.

HSCRC modified the guiding principles of those originally established for the MHAC program to conform to the goals of its new All-Payer Model agreement with CMMI; they include the following:

- The program must improve care for all patients, regardless of payer.
- The breadth and impact of the program must meet or exceed the Medicare national program in terms of measures and revenue at risk.
- The program should identify predetermined performance targets and financial impact.
- An annual target for the program must be established in the context of the trends of complication reductions seen in the previous years, as well as the need to achieve the new All-Payer Model goal of a 30 percent cumulative reduction by 2018.
- The program should prioritize PPCs that have high volume, high cost, opportunity for improvement, and are areas of national focus.
- Program design should encourage cooperation and sharing of best practices.
- The scoring method should hold hospitals harmless for a lack of improvement if attainment is highly favorable.
- Hospitals should have the ability to track their progress during the performance period.

HSCRC also modified the program's methodology to achieve these new goals and guiding principles under the new All-Payer Model agreement. These changes affected performance years beginning with calendar year (CY) 2014, which were applied to rate years beginning with FY 2016.⁸ The key changes to the methodology are listed below (see Appendix II for a more detailed description of the revised methodology).

⁸ The performance period for PPCs is measured on a calendar year basis, and the results of these measures are then used in the hospitals' rate calculations, which are set on a fiscal year basis.

- Determining hospital scores based on case-mix-adjusted PPC rates rather than excess PPC costs. The rationale for this change was to simplify and align the measurement with the quality improvement methods, where hospitals focus shifted to the PPC rates rather than the number of excess PPCs and costs.
- Prioritizing PPCs that are high cost, high volume, have opportunity to improve, and are of national concern by grouping and weighting the PPCs into three tiers according to their level of priority. This tiering approach replaced the previous PPC-specific weighting approach that used marginal costs, which changed the weights of a small number of PPCs significantly from year to year— it should be noted that this in turn created challenges for hospitals to have a continued focus on high-rate PPCs.
- Using the better of attainment or improvement scores, which will strengthen incentives for low-performing hospitals to improve. Previously, payment adjustments were calculated separately for hospital attainment and improvement rates that were based on a few PPCs.
- In determining payment rewards/penalties, using a preset point scale developed with base year scores. This was a shift from the original approach to determining payment adjustments, which were calculated based on the relative ranking of hospitals, to improve the financial predictability of the program. In addition, the revised methodology lifts the revenue neutrality requirement (i.e., the statewide total amount of rewards can exceed the total amount of penalties) in scaling payments to reward hospitals with better performance adequately.
- Linking individual hospital performance with statewide performance by creating a “contingent” payment adjustment scale, where penalties are increased if the state does not reach pre-determined PPC reduction targets. Although there is substantial debate over the effectiveness of collective incentives, staff and the hospital industry believe that “contingent” scaling creates a balanced approach by maintaining hospital-level incentives with hospital-specific payment adjustments, that are also tied to a statewide improvement goal. In addition to contingent scaling, “hold-harmless zones” were created to focus payment adjustments on better and worse performing hospitals.

ASSESSMENT

In order to develop the MHAC methodology and targets for FY 2018, the HSCRC solicited input from stakeholder groups, including hospitals, payers, researchers, and other industry experts. The Performance Measurement Workgroup⁹ discussed pertinent issues and potential changes to Commission policy for FY 2018 that may be necessary to enhance the HSCRC’s ability to continue to improve the quality of care, reduce costs related to HACs, and continue to meet CMMI’s waiver targets. In its October, November, and December meetings, the Workgroup reviewed analyses and discussed issues related to 1) statewide PPC trends, 2) the list of PPCs and options for ranking this list into tiers, 3) the annual statewide MHAC adjustment target, and 4) the payment adjustment methodology. This section of the report provides an overview of the data reviewed and issues discussed by the Workgroup.

⁹ For more information on the Performance Measurement Workgroup, see <http://www.hscrc.state.md.us/hscrc-workgroup-performance-measurement.cfm>.

Statewide PPC Trends

The state continued to make significant progress in reducing complications, as measured both in terms of the actual number of PPCs and risk-adjusted PPC rates in FY 2015. Figure 1 below presents the PPC reduction trends in Maryland between FY 2010 and FY 2015. In this figure, the blue columns labeled “PPC Rates” display the number of PPC complications occurring in each year and the rate of PPC complications, which may be interpreted as the number of PPCs per 1,000 at-risk discharges. The yellow columns in the figure labeled “Annual Change” show the percent change between each year, e.g., from FY 2010 to 2011. Finally, the green columns display the percent change over the entire measurement period of FY 2010 through 2015. Because the goal of the program is to reduce PPCs, the negative percent changes in this figure may be interpreted as a performance improvement. Overall, the number and rate of PPCs decreased significantly, with a cumulative risk adjusted improvement rate of 56.6 percent between FY 2010 and 2015.

Figure 1. PPC Reduction Trends in Maryland, FY 2010-2015

	PPC RATES						Annual Change					Avg. Annual Improvement	Total Improvement
Fiscal Year	10*	11*	12*	13**	14**	15**	10-11	11-12	12-13^	13-14	14-15	10-15	10-15
TOTAL NUMBER OF PPCs	53,494	48,416	42,118	27,939	21,059	17,028	-9.5%	-13.0%	-18.8%	-24.6%	-19.1%	-17.0%	-61.0%
COMPLICATION RATE PER 1,000 AT-RISK DISCHARGES	1.92	1.77	1.58	1.25	0.97	0.8	-7.8%	-10.7%	-17.7%	-22.4%	-17.5%	-15.2%	-56.6%

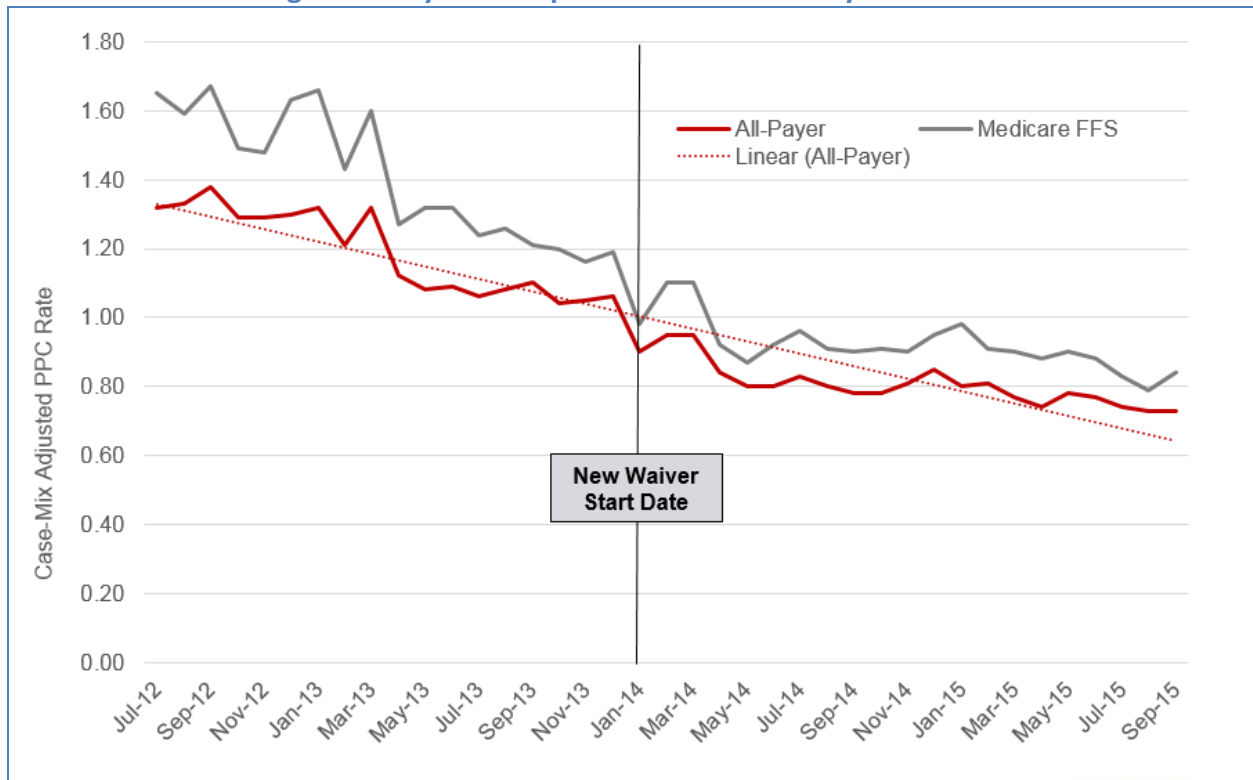
*PPC version 30 and FY 2010 norms

**PPC version 32 and FY 2014 norms

^Percent change from FY 2012 to FY 2013 uses FY 2013 values (not shown) using PPC v. 30 and FY 2010 norms.

HSCRC staff also analyzed monthly PPC rates for Medicare fee-for-service and all payers for July 2012 through September 2015 (Figure 2). The gray line in this figure shows the monthly PPC rate for Medicare fee-for-service, while the red line shows the monthly PPC rate for all payers, inclusive of Medicare fee-for-service. Both lines show a fairly consistent downward trend between July 2012 and September 2015.

Figure 2. July 2012-September 2015 Monthly PPC Rates



While Maryland has already achieved the CMMI target of a 30 percent reduction in MHACs, HSCRC staff and other stakeholders have concerns that some of this reduction may be attributable to changes in hospital coding rather than actual performance improvements. The HSCRC continues to conduct coding audits of ten hospitals per year. Following higher reduction levels in PPCs, the number of cases selected specifically for POA audits were increased substantially and additional selection criteria were added to audit PPCs with highest levels of improvement, cases with changes in their PPC status between preliminary and final data, and cases with hospice/palliative care codes. In the current auditing period, HSCRC added criteria to target PPCs that may be under-coded (e.g., cases with an excessive length of stay where no PPC was coded); staff will report findings to the Commission going forward as they become available.

PPC List and Tier Adjustments

One of the major strengths of the MHAC program compared with the CMS HAC programs is the inclusion of a wide range of complications and all patients who are at risk of developing these complications. The current MHAC program includes 65 PPCs, prioritizes them into three tiers, and assigns a higher weight to PPCs in the top tiers. Appendix III contains a list of PPCs and their tiers. While one of the guiding principles of the program calls for a comprehensive measurement strategy, this aim needs to be balanced with a desire to have a focused measurement strategy that relies on accurate and reliable measures; the accuracy and reliability of each PPC rate are important factors in considering which PPCs to include in the payment program.

HSCRC contracted with Mathematica Policy Research to conduct analyses testing the reliability and validity of the 65 PPC measures and to make suggestions for improvement to HSCRC's methodology. Mathematica presented the results of this analysis to the Performance Measurement Workgroup during their November 20th meeting (see Appendix IV for Mathematica's Report). 3M also reviewed the results of Mathematica's analysis and provided HSCRC staff with comments. Based on the results of the Mathematica analysis and input from 3M and the Performance Measurement Workgroup, HSCRC staff support the following changes to the PPC list and the tiering methodology for FY 2018:

- Moving from a three-tiered PPC weighting system to a two-tiered weighting system, with tier 1 weighted at 100 percent and tier 2 weighted at 50 percent in the scoring calculations. The rationale for this change is to simplify the scoring and payment adjustment calculations for the program. Staff recommend to include about one-third of the measures in tier 1. There was general consensus among Performance Measurement Workgroup members for this change in approach.
- Combining some PPC measures that are clinically similar for scoring purposes. The rationale for this change is to improve the reliability of some of the measures and to account for the infrequent occurrence (small cell sizes) of some of the measures. For example, for two separate PPCs related to gastrointestinal complications, Mathematica found that these measures individually have low reliability, so HSCRC staff recommend combining them into a single measure to improve their reliability. In addition to the statistical attributes of the PPCs, the clinical relationships among candidate combinations are an important factor in considering whether to combine PPCs. A few PPCs with a low number of cases in the lowest weighted tier were combined in FY 2017. There was some disagreement among Performance Measurement Workgroup members on which specific measures to combine for FY 2018 based on the expanded list of PPCs that scored low on reliability and validity testing. Overall, staff support creating a handful of combination measures for FY 2018.
- Moving a small subset of PPCs to a "monitoring" status, suspending their use for payment calculation for FY 2018. While some Workgroup members advocated for suspending additional measures, other members were concerned that suspending a measure would diminish its importance. Specifically, there was discussion about suspending some of the serious but rare PPCs (i.e., never-events) due to the fact that the infrequent occurrence led to low reliability. Overall, staff support suspension of a handful of PPC measures for FY 2018. However, staff recommend to continue to include serious but rare complications because of their clinical significance.

In late December, staff circulated the PPC list, recommendations for PPC tiers, and recommendations for combining and suspending measures to the Performance Measurement Workgroup members and requested feedback prior to the next Workgroup meeting in late January. In reviewing the data, HSCRC staff found that changes to the PPC list—whether combining or suspending the PPCs—had minimum impact on overall hospital scores in the MHAC program. Staff support the inclusion of a small number of low-volume PPCs that Mathematica determined to have low statistical reliability (likely due to their small numbers) because when these PPCs occur, they constitute significant clinical events of concern. Staff will finalize the list after receiving the requested feedback and issue a memorandum to the industry with the final PPC list. The PPC list with staff recommendations is in Appendix V.

Annual Statewide MHAC Reduction Target

Setting a statewide MHAC reduction target is crucial in the new MHAC methodology, as the maximum penalty would be higher if the target is not met. In the initial years, the statewide target was calculated based on historical improvement rates and the five-year 30 percent improvement target established by the new All-Payer Model agreement. In FY 2016, the statewide MHAC reduction target was 8 percent, and this was reduced to 7 percent in FY 2017. HSCRC staff presented a recommended reduction target of 6 percent in the draft recommendation and presented to the Performance Measurement Workgroup. In a letter dated January 4, 2016, the Maryland Hospital Association expressed disagreement with this improvement target and recommended instead that the policy should focus on sustaining the gains that Maryland has already made. Other Workgroup members, however, asserted that a significant portion of Maryland's improvement could be a result of coding changes rather than an actual improvement in the quality of care and proposed that the improvement targets should be set higher. In a letter dated December 15, Jonathan Blum, representing CareFirst BlueCross BlueShield, voiced concern about the dramatic level of improvement in the MHAC program, with PPC reductions of 33-36 percent, and supported investigating potential factors contributing to these results.¹⁰ Some Workgroup members also advocated for stronger improvement targets in light of the fact that HACs are included in Maryland hospitals' global budget calculations, whereas Medicare does not pay for HACs in other states. HSCRC staff emphasized the need to continue to improve care and reduce costs by reducing PPC rates and requested Workgroup members to provide suggestions for estimating the extent to which the MHAC improvements are a result of coding changes.

Based on these discussions and a broad range of opinions voiced, staff recommend setting a 6 percent improvement target for FY 2018, which is consistent with observed trends and is a reduction from last year's 7 percent improvement target. Although substantial improvements have been realized, a significant variation exists in hospital PPCs rates, which provides potential for further improvements and would be in line with continuous quality improvement as part of the three-part aim. Staff are currently analyzing MHAC results in light of other quality measurement results, such as the Centers for Disease Control and Prevention's National Healthcare Safety Network infection rate measures, but caution that measures with differing specifications may be correlated but should not yield the same results.

Payment Adjustment Methodology

Staff do not recommend any changes to the payment adjustment methodology at this time. The CY 2014 changes to the MHAC program, which were first applied to FY 2016 hospital rates, were considered in conjunction with one another and had broad stakeholder support. In addition to changes in the PPC measurement and scoring methodology, the payment methodology was revised substantially in multiple related dimensions.

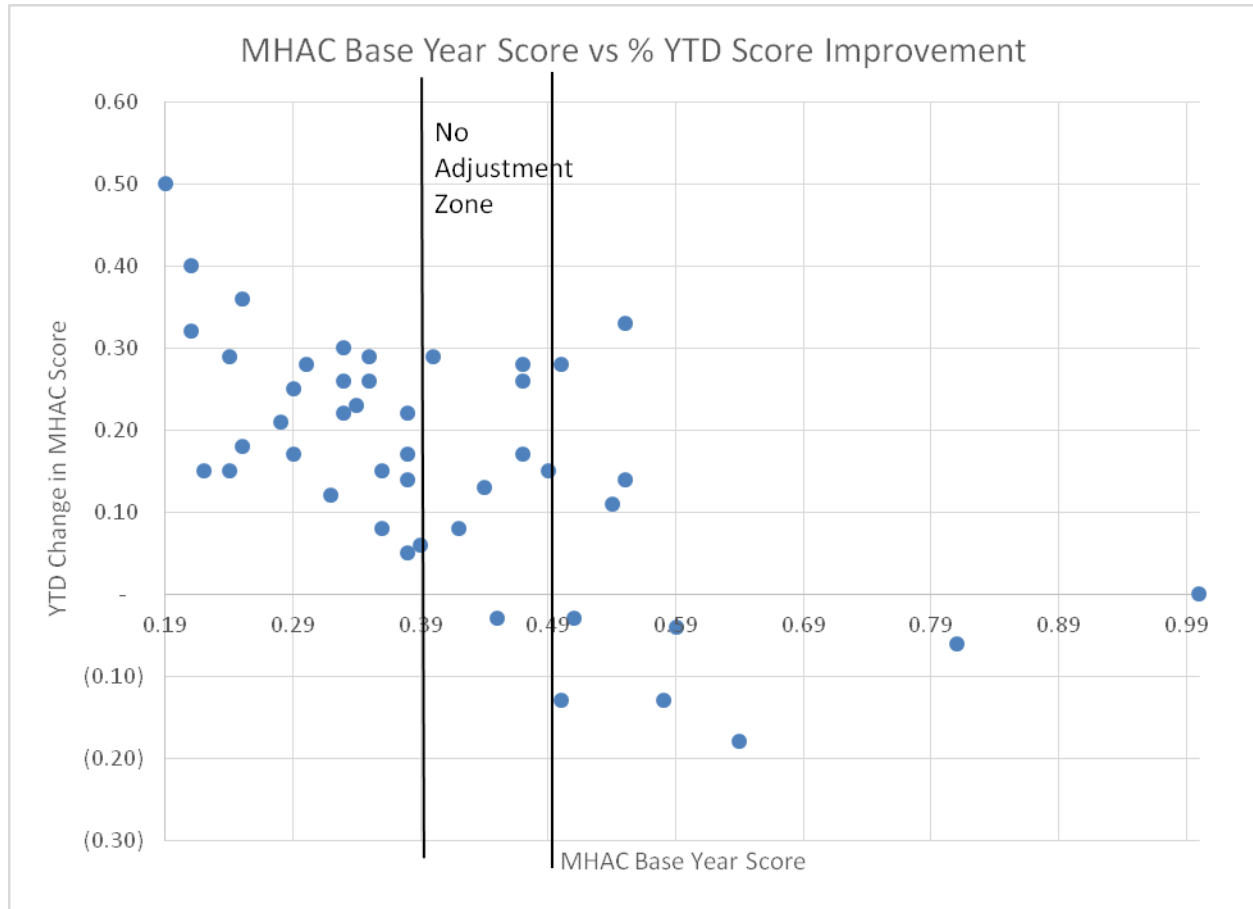
¹⁰ Staff received only two comment letters, which are included at the end of this recommendation.

In his December 15th letter, Jonathan Blum, representing CareFirst BlueCross BlueShield, asserted that the MHAC program would be enhanced with some changes to the payment adjustment methodology. First, Mr. Blum recommended replacing the two-tiered scaling approach with a single scale without a hold-harmless zone. He stated that this would provide incentives that are proportionate to hospital performance and increase individual accountability. Second, Mr. Blum recommended, rather than using two scales with higher amounts of revenue at risk if a statewide collective PPC reduction target is not met, applying a penalty to all hospitals as part of the update factor determination after the performance period is completed if the statewide improvement target is not met. This would support the sharing of information and best practices among hospitals.

Staff continue to advocate that a contingent scaling approach provides strong incentives for collaboration between hospitals to share best practices and continue to improve to ensure that the statewide target is achieved. Appendix VI presents pre-set scaling points and year to date results for FY2017. Based on the results using January to September data, four hospitals are receiving a penalty totaling \$2 million, 12 hospitals are in the hold-harmless zone and 30 hospitals are receiving rewards, totaling \$17.5 million as the state met the reduction goal of 7 percent. Staff note that applying a penalty after the fact, as recommended by CareFirst, would contradict with the program principle of determining program impact ahead of the performance period. Even if the determination is made after the fact, a blanket penalty applied to all hospitals regardless of their PPC performance would not produce a fair assessment of hospital performance. Staff believes that statewide improvement goal is still needed to continue the progress and balance collective accountability with hospital level performance.

In evaluating the impact of the hold-harmless zone, staff analyzed the year-to-date results in PPC scores to examine whether hospitals that started in the hold-harmless zone improved. Figure 3 plots the changes in MHAC scores (vertical axis) against the baseline scores (horizontal axis), which have a range of 0.17 to 1 points. The FY 2017 scale set the no-adjustment zone between 0.40 to 0.50 points based on the distribution of hospitals in the base year. As the chart indicates, all but one hospital in the hold-harmless zone continued to improve. The average improvement was 0.22 points for the hospitals in the penalty zone, 0.15 points for those that started in the no-adjustment zone, and 0.02 points for those that were in the reward zone. It is important to note that as the maximum score cannot exceed 1 point, the opportunity to improve diminishes with higher scores. The data indicate that hospitals in the hold-harmless zone continued to improve, likely reflecting the impact of contingent scaling (they would have received penalties if the state did not meet the target) and incentives to achieve positive financial adjustments.

Figure 3. A Comparison of Hospital's Base Year MAC Score with Year-to-Date Improvement



Some Workgroup members expressed concern about the impact of small hospitals on establishing the expected PPC benchmark values, noting that the majority of the high-performing hospitals are small hospitals. HSCRC staff note that this is consistent with national quality programs since, according to a Government Accounting Office analysis of the federal Hospital Value-Based Purchasing program, small hospitals and hospitals with better financial performance generally had higher payment adjustments, i.e., larger bonuses or smaller penalties.¹¹ As the benchmarks for full points are set at the top 25 percent of the best performing hospital levels, small hospitals are also contributing disproportionately to setting the scores of the rest of the hospitals in the state. Staff are evaluating the impact of small hospitals on benchmarks and will work with the Performance Measurement Workgroup to make adjustments that would mitigate some of these concerns. In addition to the impact of the size of the hospitals, the PPC measures tend to focus on surgical cases, which may contribute to differential performance among hospitals. Although risk adjustment accounts for differences in all-patient refined

¹¹ United States Government Accounting Office. (2015, October). Hospital Value-Based Purchasing, Report to Congressional Committees. Retrieved from. <http://www.gao.gov/assets/680/672899.pdf>

diagnosis-related groups (APR DRG) and severity of illness (SOI) levels between hospitals, the number of PPCs in which each hospital is measured against may vary depending on hospitals' service lines. For example, hospitals that provide obstetrical services would be measured against additional PPCs related to obstetrical care that would not apply to hospitals that do not provide obstetrical care. Shifting the pay-for-performance programs' focus to condition-specific measures is a goal that staff believe holds great promise moving forward. This condition-specific focus would allow for the creation of composite measures that combine different dimensions of quality measurement on a specific group of patients, such as readmissions, complications, mortality, patient satisfaction, avoidable utilization, and costs. The Performance Measurement Work group will discuss these approaches in the strategic planning process in the context of the larger set of programs and overarching system goals in the upcoming months.

RECOMMENDATIONS

Based on this assessment, HSCRC staff recommend keeping the current FY2017 MHAC methodology for FY2018, as this current approach balances hospital-specific incentives with state goals, sets continuous specific quality improvement goals, and focuses the payment adjustments to best and worst performers. Below are the specific recommendations to update the MHAC policy for FY 2018:

- 1) The program should continue to use the same scaling approach:
 - a) The program should continue the contingent scaling approach, where a higher level of revenue is at risk if the statewide improvement target is not met. Rewards should only be distributed if the statewide improvement target is met.
 - b) Hold-harmless zones should be created to focus the payment adjustments to both ends of the performance spectrum.
 - c) Rewards should not be limited to the penalties collected.
- 2) The statewide reduction target should be set at 6 percent, comparing FY 2015 with CY 2016 risk-adjusted PPC rates.

APPENDIX I.

MEASURES FOR THE FEDERAL HAC PROGRAM

CMS HAC MEASURES Implemented Since FFY 2012

HAC 01: Foreign Object Retained After Surgery
HAC 02: Air Embolism
HAC 03: Blood Incompatibility
HAC 04: Stage III & Stage IV Pressure Ulcers
HAC 05: Falls and Trauma
HAC 06: Catheter-Associated Urinary Tract Infection
HAC 07: Vascular Catheter-Associated Infection
HAC 08: Surgical Site Infection - Mediastinitis After Coronary Artery Bypass Graft (CABG)
HAC 09: Manifestations of Poor Glycemic Control
HAC 10: Deep Vein Thrombosis/Pulmonary Embolism with Total Knee Replacement or Hip Replacement
HAC 11: Surgical Site Infection – Bariatric Surgery
HAC 12: Surgical Site Infection – Certain Orthopedic Procedure of Spine, Shoulder, and Elbow
HAC 13: Surgical Site Infection Following Cardiac Device Procedures
HAC 14: Iatrogenic Pneumothorax w/Venous Catheterization

CMS HAC Reduction Program Measures Implemented Since FFY 2015

- Domain 1- the Agency for Health Care Research and Quality composite PSI #90 which includes the following indicators:
 - o Pressure ulcer rate (PSI 3);
 - o Iatrogenic pneumothorax rate (PSI 6);
 - o Central venous catheter-related blood stream infection rate (PSI 7);
 - o Postoperative hip fracture rate (PSI 8);
 - o Postoperative pulmonary embolism (PE) or deep vein thrombosis rate (DVT) (PSI 12);
 - o Postoperative sepsis rate (PSI 13);
 - o Wound dehiscence rate (PSI 14); and
 - o Accidental puncture and laceration rate (PSI 15).
- Domain 2- two healthcare-associated infection measures developed by the Centers for Disease Control and Prevention's (CDC) National Health Safety Network:
 - o Central Line-Associated Blood Stream Infection and
 - o Catheter-Associated Urinary Tract Infection.

For the FY 2017 CMS HAC Reduction program, CMS decreased the Domain 1 weight from 25 percent to 15 percent and increased the Domain 2 weight from 75 percent to 85 percent.

CMS also expanded the data used for CLABSI and CAUTI measures and will include data from pediatric and adult medical ward, surgical ward, and medical/surgical ward locations, in addition to data from adult and pediatric ICU locations.

APPENDIX II.

PPC MEASUREMENT DEFINITION AND POINTS CALCULATION

Definitions

The PPC measure would then be defined as:

Observed (O)/Expected (E) value for each measure

The threshold value is the minimum performance level at which a hospital will be assigned points and is defined as:

Weighted mean of all O/E ratios ($O/E = 1$)

(Mean performance is measured at the case level. In addition, higher volume hospitals have more influence on PPCs' means.)

The benchmark value is the performance level at which a full 10 points would be assigned for a PPC and is defined as:

Weighted mean of top quartile O/E ratio

For PPCs that are serious reportable events, the benchmark will be set at 0.

Performance Points

Performance points are given based on a range between a “Benchmark” and a “Threshold,” which are determined using the base year data. The Benchmark is a reference point defining a high level of performance, which is equal to the mean of the top quartile. Hospitals whose rates are equal to or above the benchmark receive 10 full attainment points.

The Threshold is the minimum level of performance required to receive minimum attainment points, which is set at the weighted mean of all the O/E ratios which equals to 1. The improvement points are earned based on a scale between the hospital's prior year score (baseline) on a particular measure and the Benchmark and range from 0 to 9.

The formulas to calculate the attainment and improvement points are as follows:

- Attainment Points: $[9 * ((\text{Hospital's performance period score} - \text{threshold}) / (\text{benchmark} - \text{threshold}))] + .5$, where the hospital performance period score falls in the range from the threshold to the benchmark
- Improvement Points: $[10 * ((\text{Hospital performance period score} - \text{Hospital baseline period score}) / (\text{Benchmark} - \text{Hospital baseline period score}))] - .5$, where the hospital performance score falls in the range from the hospital's baseline period score to the benchmark.

APPENDIX III.
MHAC FY 2017 PPC LIST, TIERS, AND WEIGHTING

PPC #	PPC Description	Threshold	Benchmark	Tier
1	Stroke & Intracranial Hemorrhage	1	0.5241	3
2	Extreme CNS Complications	1	0.3027	3
3	Acute Pulmonary Edema and Respiratory Failure without Ventilation	1	0.4884	1
4	Acute Pulmonary Edema and Respiratory Failure with Ventilation	1	0.4837	1
5	Pneumonia & Other Lung Infections	1	0.4365	1
6	Aspiration Pneumonia	1	0.5393	1
7	Pulmonary Embolism	1	0.3464	1
8	Other Pulmonary Complications	1	0.3321	2
9	Shock	1	0.3119	1
10	Congestive Heart Failure	1	0.2272	2
11	Acute Myocardial Infarction	1	0.4624	2
12	Cardiac Arrhythmias & Conduction Disturbances	1	0.5443	3
13	Other Cardiac Complications	1	0.165	3
14	Ventricular Fibrillation/Cardiac Arrest	1	0.5482	1
15	Peripheral Vascular Complications Except Venous Thrombosis	1	0.3271	3
16	Venous Thrombosis	1	0.2739	16
17	Major Gastrointestinal Complications without Transfusion or Significant Bleeding	1	0.5111	2
18	Major Gastrointestinal Complications with Transfusion or Significant Bleeding	1	0.086	2
19	Major Liver Complications	1	0.3394	2
20	Other Gastrointestinal Complications without Transfusion or Significant Bleeding	1	0.441	3
21	Clostridium Difficile Colitis	1	0.3427	3
23	GU Complications Except UTI	1	0.1973	3
25	Renal Failure with Dialysis	See Combined PPC 67		3
26	Diabetic Ketoacidosis & Coma			3
27	Post-Hemorrhagic & Other Acute Anemia with Transfusion	1	0.5607	2
28	In-Hospital Trauma and Fractures	1	0.3471	1
29	Poisonings Except from Anesthesia	1	0.185	3
30	Poisonings due to Anesthesia	0	0	3
31	Decubitus Ulcer	0	0	1
32	Transfusion Incompatibility Reaction	0	0	3
33	Cellulitis	1	0.3511	3
34	Moderate Infectious	1	0.0533	3
35	Septicemia & Severe Infections	1	0.3298	1
36	Acute Mental Health Changes	1	0.2437	3
37	Post-Operative Infection & Deep Wound Disruption Without Procedure	1	0.5343	1

PPC #	PPC Description	Threshold	Benchmark	Tier
38	Post-Operative Wound Infection & Deep Wound Disruption with Procedure	1	0.1119	1
39	Reopening Surgical Site	1	0.3355	3
40	Post-Operative Hemorrhage & Hematoma without Hemorrhage Control Procedure or I&D Proc	1	0.6201	1
41	Post-Operative Hemorrhage & Hematoma with Hemorrhage Control Procedure or I&D Proc	1	0.0583	2
42	Accidental Puncture/Laceration During Invasive Procedure	1	0.5286	1
43	Accidental Cut or Hemorrhage During Other Medical Care	See Combined PPC 67		3
44	Other Surgical Complication - Mod	1	0.3496	3
45	Post-procedure Foreign Bodies	0	0	3
46	Post-Operative Substance Reaction & Non-O.R. Procedure for Foreign Body	0	0	3
47	Encephalopathy	1	0.2274	3
48	Other Complications of Medical Care	1	0.4184	2
49	Iatrogenic Pneumothorax	1	0.1123	1
50	Mechanical Complication of Device, Implant & Graft	1	0.3371	3
51	Gastrointestinal Ostomy Complications	1	0.1031	3
52	Inflammation & Other Complications of Devices, Implants or Grafts Except Vascular Infection	1	0.5224	3
53	Infection, Inflammation & Clotting Complications of Peripheral Vascular Catheters & Infusions	1	0.1142	3
54	Infections due to Central Venous Catheters	1	0.1906	1
55	Obstetrical Hemorrhage without Transfusion	1	0.5011	3
56	Obstetrical Hemorrhage with Transfusion	1	0.4447	3
57	Obstetric Lacerations & Other Trauma Without Instrumentation	1	0.6149	3
58	Obstetric Lacerations & Other Trauma With Instrumentation	1	0.3936	3
59	Medical & Anesthesia Obstetric Complications	1	0.4924	3
60	Major Puerperal Infection and Other Major Obstetric Complications	1	0.166	3
61	Other Complications of Obstetrical Surgical & Perineal Wounds	1	0.3701	3
62	Delivery with Placental Complications	1	0.2963	3
63	Post-Operative Respiratory Failure with Tracheostomy	See Combined PPC 67		3
64	Other In-Hospital Adverse Events			3
65	Urinary Tract Infection without Catheter	1	0.5268	1
66	Catheter-Related Urinary Tract Infection	1	0	1
67	Combined PPC* (PPC 25, 26, 43, 63, 64)	1	0.1301	3

*Starting in FY 2017, these Tier 3 PPCs with a low benchmark and weight were combined into 1 PPC.

APPENDIX IV.
MATHEMATICA POLICY RESEARCH REPORT

REPORT

FINAL REPORT

Reliability and Validity Testing Results for Potentially Preventable Complication (PPC) Measures in the MHAC Program

December 31, 2015

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EXECUTIVE SUMMARY

Measures of quality are the foundation of the programs implemented by the Health Services Cost Review Commission to promote improved quality of care in Maryland hospitals. The effectiveness and fairness of one such program, the Maryland Hospital Acquired Condition (MHAC) program, are underpinned by the statistical reliability and validity of the Potentially Preventable Complication (PPC) measures used to calibrate consequential program components such as hospital rankings and provider incentives.

In this study we test the statistical reliability, predictive validity, and convergent validity of the PPC measures used in the MHAC program.

Reliability testing compares the meaningful signal (i.e., between-provider variation) of the measure result against the unrelated noise (i.e., within-provider variation). A measure with high reliability can distinguish providers according to their measure results.

Validity testing assesses whether the measure result accurately reflects underlying performance. We focus on two components in this study:

- *Predictive validity*, which evaluates the ability of current measure results to predict future performance. We assess predictive validity by correlating results for the same PPC in different time periods (from calendar year [CY] 2012 to quarters 1 and 2 of CY 2015).
- *Convergent validity*, which assesses the agreement between current measure results and commensurate external measures and criteria. We address convergent validity by correlating PPCs with analogous Patient Safety Indicators (PSIs) developed by the Agency for Healthcare Research and Quality and with all-payer mortality rates.

Key findings

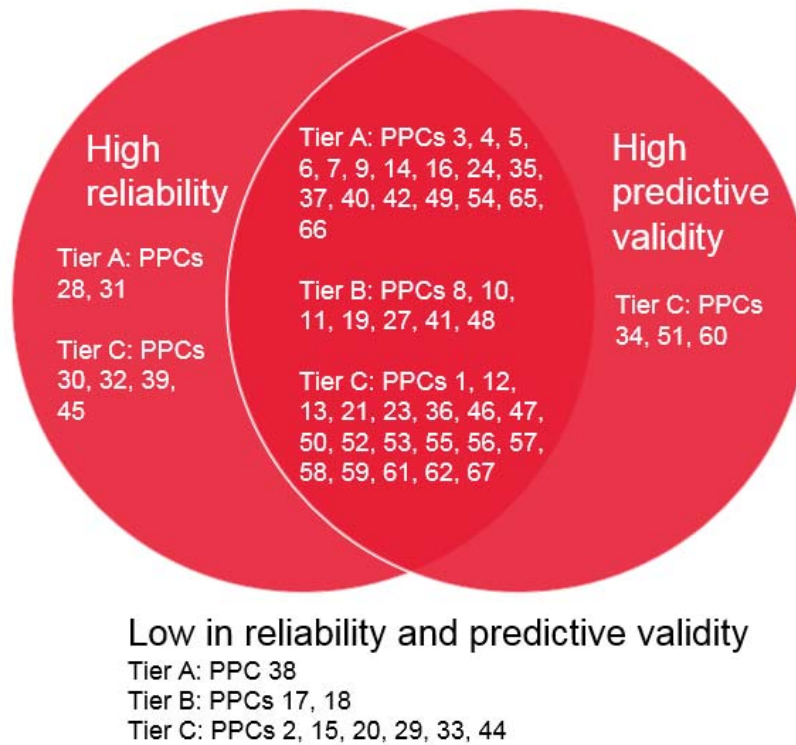
Our testing of the reliability and validity of PPCs in the MHAC program showed the following:

- **As used in the MHAC program, most PPC measures demonstrate moderate to high reliability and adequate predictive validity.** In tier A,¹ which contains the highest-priority measures given the greatest weight in score calculations, all PPCs but one (PPC 38) show moderate to high reliability or adequate validity. Among all PPCs, nine (15 percent) are low in reliability and predictive validity, but most of these are in tier C, as summarized in Figure ES.1.

¹ In the current MHAC program, PPCs are classified into three tiers based upon their costs and prevalence among hospitals. Specifically, tier A includes statewide high-cost, high-volume PPCs and those matching hospital-acquired conditions (HACs) in the Centers for Medicare & Medicaid Services (CMS) HAC Reduction Program. Remaining PPCs with high Medicare frequency (> 60 percent) and high number of occurrences in Maryland hospitals (> 43) are classified in tier B. The remaining PPCs are in tier C. The weights for each tier are as follows: 100 percent for tier A, 60 percent for tier B, and 40 percent for tier C.

- **Correlation of PPC measures with risk-adjusted mortality and PSI rates demonstrates the convergent validity of PPCs.** Of PPCs that can be matched with similar PSIs, only one lacks a statistically significant correlation with its analog. PPC 38 has consistently low correlations with its PSI counterpart (PSI 14), possibly due to its low reliability and low predictive validity. Several PPCs are positively correlated with all-payer mortality. Several PPCs are positively correlated with all-payer mortality.

Figure ES.1. Classification of PPCs based on reliability and predictive validity testing



Recommendations

Based on our findings, we recommend testing how PPCs with low reliability scores can be combined into composite measures; in cases of very low scores, we recommend testing the impact of removing them from the program. We tested the strategy of raising the minimum sample size threshold of both at-risk cases and expected PPC cases but found it did not meaningfully improve the reliability of measures included in the program.

We recommend monitoring of PPCs' reliability and validity in future years in response to changes in coding practices and improvements in hospital performance. For example, implementation of ICD-10 or changes in coding practice may affect measure properties. Performance improvements may affect the stability of norms used to standardize the measures and variation in hospitals' performance, and hence reliability.

I. OVERVIEW

A. Background on the MHAC program

The Health Services Cost Review Commission (HSCRC) implemented hospital quality initiatives to encourage high quality and efficient patient care. Hospital quality measures are tied to reimbursement under the Maryland Hospital Acquired Conditions (MHAC) program, Quality Based Reimbursement program, and Readmissions Reduction Incentive Program, all of which incentivize hospitals to improve quality and efficiency.

The MHAC program was implemented in state fiscal year (FY) 2011.² Its purpose is to link hospital payment to hospital performance for a set of Potentially Preventable Complication (PPC) measures developed by 3M Health Information Systems. PPCs are defined as complications occurring during hospital admission that may result from care and treatment rather than underlying disease progression. HSCRC monitors hospitals' performance in the MHAC program through scores based on hospitals' risk-adjusted PPC measures during the performance period. The MHAC scoring methodology provides a system of payment incentives based on how a hospital's complication rates compare to statewide target rates for each of the selected MHAC categories. Under this approach, hospitals have financial incentives to reduce complication rates.³

The effectiveness and fairness of the MHAC program is underpinned by the statistical reliability and validity of the measures used to calibrate consequential program components such as hospital rankings and provider incentives. Valid and reliable measures make it more likely that hospitals' efforts to improve their rates will result in both better care and financial benefits. To support HSCRC's assessment of the effectiveness and fairness of the MHAC program, we conducted systematic reliability and validity testing of all PPC measures in the program. This testing should shed light on whether measured increases in PPC occurrence reflect an actual increase in complications, or – as some members of the Performance Measurement and Payment Models Workgroup speculate – are due instead to changes over time in measurement practices and in the interpretation of PPC definitions (HSCRC 2015).

B. Reliability and validity testing methods

In this report, we present the results of tests of the statistical reliability, convergent validity, and predictive validity of PPC measures:

- Reliability testing compares between-provider variation (signal) and within-provider sampling variation (noise).
- Validity testing is of two types:
 - Predictive validity is judged by the correlation of PPCs across years from calendar year (CY) 2012 to quarters 1 and 2 of CY 2015.

² The state of Maryland 2011 fiscal year runs from July 1, 2010, to June 30, 2011.

³ Maryland HSCRC, "Complications: Maryland Hospital Acquired Conditions (MHAC)," http://www.hscrc.state.md.us/init_qi_MHAC.cfm.

- o Convergent validity is judged by the correlation of PPC measure results with external measures, specifically Patient Safety Indicators (PSIs) from the PSI-90 Composite⁴ and all-payer mortality rates.

1. Reliability testing

In reliability testing, we calculate reliability as the signal-to-noise ratio, which is the ratio of the variation in hospital performance rates to the total variation of the measure (which includes random fluctuation). In other words, reliability informs us whether differences in measure results between providers are due to differences in their underlying performance. The signal variance characterizes the magnitude of differences in underlying performance between providers, also known as between-hospital variance. The total variation is calculated by adding to the signal variance other random variation – for example, variation due to sampling (noise variance). Thus

$$\text{Measure reliability} = \frac{\text{signal variance}}{\text{signal variance} + \text{noise variance}}$$

Reliability can be measured for each hospital and increases with the sample size of observations available from that hospital, as sampling variance is reduced. In general, high measure reliability implies that the differences in hospitals' measure results are meaningful for distinguishing their performance.

We estimate the signal and noise variance components for reliability through a two-stage statistical model, where the between-hospital variation is calculated using a beta-binomial model (Adams 2009). A detailed specification of the reliability method can be found in Appendix A.

2. Predictive validity

Predictive validity indicates that current measure results can be used as a criterion to evaluate future performance. In the MHAC program, PPC measures are used to monitor hospitals' performance and incentivize them to improve the quality of care they offer. For instance, in the FY 2017 MHAC program, a hospital's payment adjustment is determined by its PPC performance in CY 2015. In order for improvement in rates to identify improvement in performance, differences in rates should be consistently related to differences in performance, expressed in the correlation of hospitals' results over time. A PPC measure with relatively stable measure results and trend indicates that the measure can be used to monitor a hospital's underlying improvement over time, and that changes in measure results are not caused by random fluctuations such as errors, or changes in coding practice. In the predictive validity test, we analyze the correlations for hospital PPC rates across years using data from CY 2012 to the first two quarters in CY 2015. A PPC measure has predictive validity if it exhibits a significant positive correlation between consecutive time periods.

3. Convergent validity

Convergent validity captures the degree to which the tested measure agrees with external measures or criteria that are commensurate with the underlying construct of interest (Sireci

⁴ PSI-90 Composite is a weighted average of the reliability-adjusted observed-to-expected ratios of 11 PSIs. See AHRQ (2010).

2005). In convergent validity testing, we examine the weighted correlations of hospitals' PPC rates with their rates for analogous PSIs from the PSI-90 Composite for three different year-long time periods (FY2013, FY2014, and CY2014). To account for the sample size effect, each hospital is weighted based upon the number of PPCs expected in that hospital in FY 2014.⁵ We confirm a PPC with strong convergent validity if the weighted correlation is statistically significant ($p < .05$) over time. In addition, we conduct correlation analysis between hospitals' PPC rates and their all-payer risk-adjusted mortality rates. These are measures that are also expected to improve with improvements in patient safety. Thus a positive correlation evidences the validity of PPCs, PSIs, and mortality measures.

II. RELIABILITY TESTING RESULTS

A. Data source

Reliability is estimated using PPC performance metrics based on PPC counts during two years, FY 2014 and FY 2015; metrics are risk adjusted using FY 2014 norms.

B. Reliability testing results

1. PPC measure-level reliability summary

We choose 0.4 for the value of reliability below which we deem a measure to have low reliability. In other words, a PPC is reliable if at least 40 percent of its total variation comes from the signal variance. According to this criterion, 12 PPCs have low reliability based on testing results. Nine of these 12 PPCs are in tier C, whereas only one – PPC 38 – is in tier A (Table II.1). Generally, PPC measures in tier A tend to have higher reliability than PPCs in tiers B and C. A more detailed reliability summary of each PPC can be found in Appendix B.

Table II.1. PPCs with low reliability

Low-reliability PPC ^a	Description	Tier	Number of hospitals with the PPC	Number of hospitals with low reliability rate for PPC ^b	Percentage of hospitals with low reliability rate for PPC
38	Post-Operative Wound Infection & Deep Wound Disruption with Procedure	A	23	23	100.0
17	Major Gastrointestinal Complications Without Transfusion or Significant Bleeding	B	41	27	65.9
18	Major Gastrointestinal Complications with Transfusion or Significant Bleeding	B	38	38	100.0
2	Extreme CNS Complications	C	31	22	71.0
15	Peripheral Vascular Complications Except Venous Thrombosis	C	29	29	100.0

⁵ The FY 2017 MHAC program uses FY 2014 data as norm for the risk adjustment.

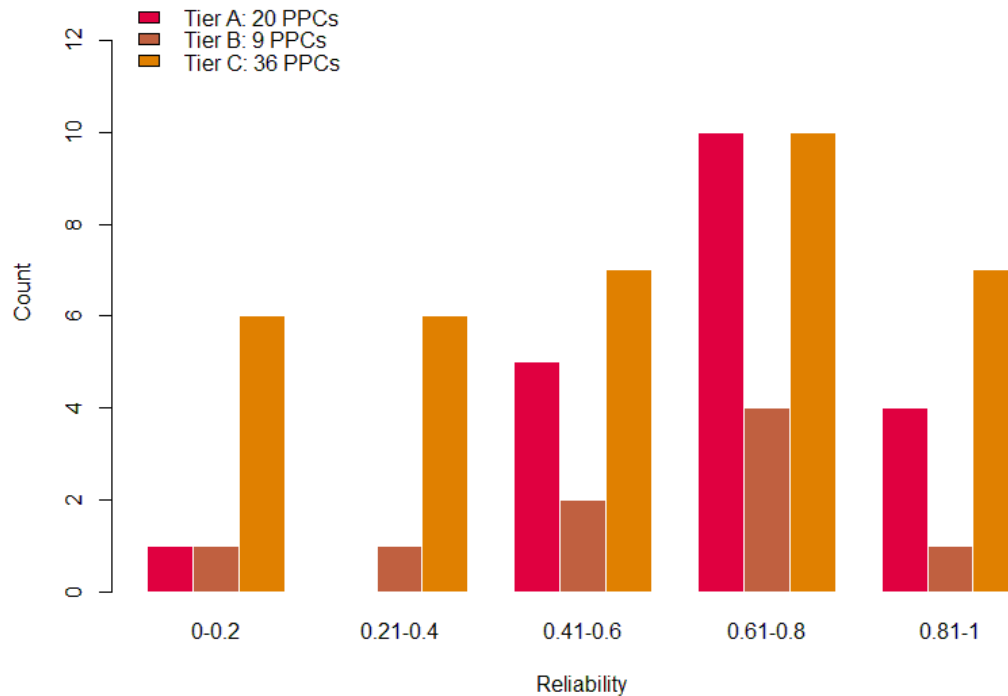
Low-reliability PPC ^a	Description	Tier	Number of hospitals with the PPC	Number of hospitals with low reliability rate for PPC ^b	Percentage of hospitals with low reliability rate for PPC
20	Other Gastrointestinal Complications Without Transfusion or Significant Bleeding	C	34	34	100.0
29	Poisonings Except from Anesthesia	C	33	16	48.5
33	Cellulitis	C	40	26	65.0
34	Moderate Infections	C	32	27	84.4
44	Other Surgical Complication–Moderate	C	33	33	100.0
51	Gastrointestinal Ostomy Complications	C	37	24	64.9
60	Major Puerperal Infection and Other Major Obstetric Complications	C	27	27	100.0

Source: Reliability is estimated using pooled FY 2014 and FY 2015 data as performance period. All risk-adjusted PPC measures are indirectly standardized using FY 2014 norms.

^a A PPC measure is considered to have low reliability if its reliability estimate is below 0.4. The five PPCs measuring serious reportable events are excluded from the list. PPCs are listed numerically within each tier.

^b A hospital's PPC measure is considered to have low reliability if this hospital's reliability estimate for the PPC is below 0.4.

Figure II.1. Distribution of reliability estimate for PPCs, by tier



2. Hospital-level reliability summary

In addition to testing the reliability of each PPC measure, we also evaluated the reliability each hospital's rate for that PPC. The hospital-level reliability of a PPC indicates the reliability with which a hospital's PPC measure manifests its performance compared to other hospitals. PPCs with low measure-level reliability generally have low hospital-level reliabilities. For PPC 38, for example, it is difficult to distinguish any given hospital from the others (Table II.1), and the hospital-level reliabilities of this PPC, along with those of PPCs 18, 15, 20, 44, and 60, are below the 0.4 threshold for all hospitals.

We summarized hospital-level reliabilities for all PPCs by bed size and found that small hospitals exhibit more low-reliability PPCs than larger hospitals (see Table II.2). For example, hospitals with bed size between 1 and 85 have an average of 21 PPC measures with low reliability, whereas hospitals with more than 258 beds have only 11 low-reliability PPCs, on average.

Table II.2. Low hospital-level reliability PPC count, by hospital size

Bed size ^a	Low-reliability PPC count by hospital		
	Minimum count	Average count	Maximum count
1–85	7	21	28
86–200	13	21	24
201–258	11	17	22
More than 258	7	11	21

Source: Reliability is estimated using pooled FY 2014 and FY 2015 data as performance period. All risk-adjusted PPC measures are indirectly standardized using FY 2014 norms.

^a Bed size groups are determined by quartiles of bed sizes for hospitals in the MHAC program using FY 2015 data.

C. Methods to improve PPC measures' reliability and overall impact

1. Increasing the minimum case size requirement for hospital PPC exclusion

One way to improve the reliability of measures used in the program is to increase the minimum case size required for including a hospital's PPC result in its score. Increasing the minimum case size requirement would exclude PPCs for hospitals with small sample sizes (whose PPC results are subject to more sampling error).

In the FY 2017 MHAC program, a hospital's PPC result will be excluded if fewer than 10 cases are at risk for the PPC, or if the number of expected cases is less than 1. To test the effect of this change on measure reliability, we increased the threshold to 20 at-risk cases and 2 expected cases. Although this change has some positive impact on the reliability of measures used in the program, the overall effect is marginal (see Table II.3).

Table II.3. Impact on measure reliability of increasing the hospital-level PPC sample requirement

Measure reliability	Hospital-level PPC exclusion rule	
	Current rule (at-risk PPCs less than 10, or expected PPC less than 1)	Test scenario (at-risk PPCs less than 20, or expected PPC less than 2)
Minimum	0.000	0.000
1st quartile	0.395	0.378
Median	0.621	0.642
3rd quartile	0.767	0.771
Maximum	0.965	0.965

Source: Reliability is estimated using pooled FY 2014 and FY 2015 data as performance period. All risk-adjusted PPC measures are indirectly standardized using FY 2014 norms.

2. Creating composite PPCs

At the suggestion of HSCRC, we evaluated the reliability of composite measures based on combinations of clinically related PPCs. Compositing mitigates the low reliability of individual PPCs by creating a single measure with greater reliability, although it also obscures information provided by the component measures.

Table II.4 presents the estimated reliabilities of these composite PPC measures. In general, combining PPCs leads to a new measure with high reliability; the exceptions are the combinations of PPCs 29 and 30 and of PPCs 33 and 34. In a few cases, the reliability of the composite is lower than the maximum reliability among the component measures. In addition, since combining multiple PPCs into a new measure entails the loss of information contained in individual component PPCs, the programmatic and clinical implications of using composites, as well as possible alternative options, should be considered. The combination of PPCs 40, 41, 42, and 44 offers an example of possible issues arising from composites: all but PPC 44 have high reliabilities (above 0.7), whereas PPC 44 has extremely low reliability (near zero), and combining the four PPCs to mitigate the low reliability of PPC 44 would sacrifice information from the three high-reliability PPCs. An alternative to compositing would be to drop PPC 44 from the program.

Because results from PPCs are combined to create a total MHAC score, that score will be a more statistically reliable measure of hospital performance than its individual components. Composites within that total score are helpful if they produce a measure useful to hospitals or contribute to producing a total score with desirable properties. Even if new composites are created, individual component scores can still be reported to hospitals, which can use information about measure reliability and validity to judge how much significance to attach to variations in specific measures.

Table II.4. Reliability testing summary for potential composite PPCs

PPC	Description	Tier	Hospital count	Reliability
2	Extreme CNS Complications	C	31	0.349
36	Acute Mental Health Changes	C	35	0.649
Combined 2, 36			40	0.644
15	Peripheral Vascular Complications Except Venous Thrombosis	C	29	0.067
16	Venous Thrombosis	A	41	0.738
Combined 15, 16			43	0.723
17	Major Gastrointestinal Complications Without Transfusion or Significant Bleeding	B	41	0.344
18	Major Gastrointestinal Complications with Transfusion or Significant Bleeding	B	38	0.104
20	Other Gastrointestinal Complications Without Transfusion or Significant Bleeding	C	34	0.000
Combined 17, 18, 20			45	0.415
29	Poisonings Except from Anesthesia	C	33	0.395
30	Poisonings due to Anesthesia	C	46	NA ^a
Combined 29, 30			33	0.396
33	Cellulitis	C	40	0.339
34	Moderate Infections	C	32	0.319
Combined 33, 34			41	0.348
37	Post-Operative Infection & Deep Wound Disruption Without Procedure	A	42	0.485
38	Post-Operative Wound Infection & Deep Wound Disruption with Procedure	A	23	0.091
Combined 37, 38			43	0.488
40	Post-Operative Hemorrhage & Hematoma Without Hemorrhage Control Procedure or I&D Procedure	A	45	0.770
41	Post-Operative Hemorrhage & Hematoma with Hemorrhage Control Procedure or I&D Procedure	B	27	0.712
42	Accidental Puncture/Laceration During Invasive Procedure	A	43	0.810
44	Other Surgical Complication–Moderate	C	33	0.062
Combined 40, 41, 42, 44			45	0.875
60	Major Puerperal Infection and Other Major Obstetric Complications	C	27	0.118
61	Other Complications of Obstetrical Surgical & Perineal Wounds	C	31	0.634
62	Delivery with Placental Complications	C	32	0.638
Combined 60, 61, 62			32	0.617

Source: Reliability is estimated using pooled FY 2014 and FY 2015 data as performance period. All risk-adjusted PPC measures are indirectly standardized using FY 2014 norms.

^a The PPC 30 event is so rare in the performance period that its reliability cannot be evaluated based on the data. NA = not applicable.

III. VALIDITY TESTING RESULTS

A. Predictive validity

In predictive validity testing, we use data from CYs 2012, 2013, 2014, and the first two quarters of CY 2015 as separate performance periods, indirectly standardized using norms from FY 2014. We produce three pairs of correlations of PPC performance metrics from consecutive time periods: CY 2012 and CY 2013; CY 2013 and CY 2014; and CY 2014 and the first two quarters of CY 2015. We then calculate for each PPC the weighted correlation of hospital PPC performance metrics between two consecutive years, where the hospital weight is based upon the number of PPCs expected for the hospital in FY 2014 (this method accounts for the sample size effect in each hospital). Appendix C exhibits the correlation results for each PPC.

We classify a PPC's predictive validity as adequate if at least one of the PPC pairs is positively correlated with statistical significance ($p < .05$). As shown in Table , 46 of the 61 PPCs (75 percent) are adequately correlated over time according to this standard. Tier C has a higher proportion of uncorrelated PPCs (31 percent) than tier A (15 percent) and tier B (22 percent). Of the 15 uncorrelated PPCs, nine are also characterized by low reliability: PPC 38 in tier A, PPCs 17 and 18 in tier B, and PPCs 2, 15, 20, 29, 33, and 44 in tier C (see Table II.1. PPCs with low reliability).

Table III.1. Predictive validity analysis

Predictive Validity	Tier A PPCs	Tier B PPCs	Tier C PPCs
Adequate	3, 4, 5, 6, 7, 9, 14, 16, 24, 35, 37, 40, 42, 49, 54, 65, 66	8, 10, 11, 19, 27, 41, 48	1, 12, 13, 21, 23, 34, 36, 46, 47, 50, 51, 52, 53, 55, 56, 57, 58, 59, 60, 61, 62, 67
Total	n = 17 (85 percent)	n = 7 (78 percent)	n = 22 (69 percent)
Low	28, 31, 38	17, 18	2, 15, 20, 29, 30, 32, 33, 39, 44, 45
Total	n = 3 (15 percent)	n = 2 (22 percent)	n = 10 (31 percent)
Tier total	n = 20	n = 9	n = 32

B. Convergent validity

To assess convergent validity, we estimate the correlation between PPCs and external measures and corresponding Agency for Healthcare Research and Quality PSIs. As Table shows, most pairs of hospital risk-adjusted PSI rates and corresponding hospital PPC measure (or combination of PPC measures⁶) are consistently correlated. PSI 11 (postoperative respiratory failure rate) is not consistently correlated with its analog, the combination of PPCs 3, 4, and 63; this inconsistent correlation may be due to the fact that PPC 63, as a component of the composite PPC 67, has low measure reliability. The correlation of PSI 14 with PPC 38 is not statistically significant in any year; PPC 38's low measure reliability and unstable measure results may lead to the low correlations. Though a positive correlation between PSIs and PPCs is evidence of

⁶ The performance metric for combined PPCs is calculated as a ratio of summed observed PPCs over summed expected PPCs across the combined PPCs list.

validity for both measures, an absent or weak correlation is not evidence that either is invalid. Though PPCs and PSIs measure similar constructs in health care quality and patient safety, they differ in measure specifications and in the patients they target,⁷ and neither can be considered a gold standard in this comparison.

Table III.2. Correlations between PPCs and PSIs

PSI	PPC	Correlation coefficient by time period		
		FY2013	FY2014	CY2014
PSI 03: Pressure Ulcer	PPC 31: Decubitus Ulcer	0.499*	0.411*	0.466*
PSI 06: Iatrogenic Pneumothorax	PPC 49: Iatrogenic Pneumothorax	0.513*	0.618*	0.419*
PSI 07: Central Line–Associated BSI	PPC 54: Infections due to Central Venous Catheters	0.542*	0.588*	0.848*
PSI 09: Perioperative Hemorrhage or Hematoma Rate	PPC 41: Post-Operative Hemorrhage & Hematoma with Hemorrhage Control Procedure or I&D Procedure	0.169	0.568*	0.480*
PSI 11: Postoperative Respiratory Failure Rate	PPC 3: Acute Pulmonary Edema and Respiratory Failure Without Ventilation	0.229	0.532*	0.116
	PPC 4: Acute Pulmonary Edema and Respiratory Failure with Ventilation			
	PPC 63: Post-Operative Respiratory Failure with Tracheostomy			
PSI 12: Postoperative PE or DVT	PPC 7: Pulmonary Embolism PPC 16: Venous Thrombosis	0.714*	0.924*	0.880*
PSI 13: Postoperative Sepsis	PPC 35: Septicemia & Severe Infections	0.219	0.432*	0.692*
PSI 14: Postoperative Wound Dehiscence	PPC 38: Post-Operative Wound Infection & Deep Wound Disruption with Procedure	0.373	0.164	0.218
PSI 15: Accidental Puncture or Laceration	PPC 42: Accidental Cut or Hemorrhage During Invasive Procedure	0.577*	0.799*	0.768*

Source: Calculations for PPCs use base period FY 2014 and three different performance periods (CY 2013, CY 2014, and FY 2014). Calculations for PSIs reflect the risk-adjusted rate from CY 2013, CY 2014, and FY 2014, standardized using the FY 2014 norms.

* Indicates the correlation is statistically significant ($p < .05$).

The hospital mortality rate is another external measure that can be used to confirm convergent validity. Table III.3 shows several PPC measures strongly correlated with the all-payer risk-adjusted mortality rate. Such results are evidence that PPCs have convergent validity.

⁷ For example, the inclusion and exclusion rules differ for PPCs and the related PSIs. In addition, most PSIs are restricted to surgical patients, whereas most of their PPC counterparts consider both surgical and medical patients.

In the case of PPC 2, these results indicate that monitoring may be important in spite of the PPC's low reliability.

Table III.3. PPCs that are highly correlated with mortality rates

PPC ^a	Description	Tier	Correlation with mortality rate	Also low reliability?
4	Acute Pulmonary Edema and Respiratory Failure with Ventilation	A	0.405	No
9	Shock	A	0.388	No
14	Ventricular Fibrillation/Cardiac Arrest	A	0.450	No
54	Infections due to Central Venous Catheters	A	0.389	No
2	Extreme CNS Complications	C	0.453	Yes
50	Mechanical Complication of Device, Implant & Graft	C	0.453	No
52	Inflammation & Other Complications of Devices, Implants or Grafts Except Vascular Infection	C	0.377	No

Source: PPC performance metrics use FY 2014 as base period and CY 2014 as performance period; mortality rate uses the CY 2014 risk-adjusted mortality rate.

^a PPCs are listed numerically within each tier.

IV. CONCLUSIONS

In our review of the reliability and validity of PPC measures used in the MHAC program, we found the following:

- **As used in the MHAC program, most PPC measures demonstrate moderate to high reliability and adequate predictive validity.** In tier A, which contains the highest-priority measures given the greatest weight in score calculations, all PPCs but one (PPC 38) exhibit moderate to high reliability or predictive validity. Among all PPCs, nine (15 percent) are low in reliability and predictive validity, but most of these are in the lowest-priority tier, tier C.
- **Correlation of PPC measures with risk-adjusted mortality and PSI rates demonstrates the convergent validity of PPCs.** Of PPCs that can be matched with similar PSIs, only one lacks a statistically significant correlation with its analog. PPC 38 has consistently low correlations with its PSI counterpart (PSI 14), possibly due to its low reliability and low predictive validity. Several PPCs are positively correlated with all-payer mortality.

Based on this analysis, we make the following recommendations concerning the use of PPC measures in the MHAC program:

Consider the development of PPC composites that combine low-reliability PPCs with other clinically similar PPCs. Combining relevant PPCs into a new composite measure increases the effective sample size in the measure calculation, which reduces the sampling variation and yields a new measure with increased reliability. Based on preliminary testing, the reliability of some candidate PPC composites is greater than the low reliabilities of certain component PPC measures. If an appropriate composite cannot be formed, consider dropping the measure. Considerations for developing composites include the clinical coherence of the composite created and its usefulness to hospitals. It is undesirable, for example, to combine measures across tiers, or to lose the information contained in reliable measures by combining them with unreliable measures. Moreover, the use of composites need not deprive hospitals of the information contained in individual PPCs. Even if new composites are created and used in total score calculation, component PPCs' performance can still be reported to hospitals, which can use information about the components' reliability and validity to assess the meaningfulness of changes in their rates.

Consider an increase in the minimum case size to improve effective reliability of the PPCs in the MHAC program. Based on our simulation study, increasing the PPC exclusion threshold to at-risk PPC count of less than 20 and expected PPC count of less than 2 would improve the measure reliability for some PPCs used in the MHAC program. Preliminary testing shows that the improvement is marginal, however, and although higher standards in PPC inclusion might produce greater improvement, increasing the threshold could also have detrimental effects. For example, MHAC scores for small hospitals would be based on fewer measures, which might make them incommensurate with scores of large hospitals based on more measures.

Conduct annual reviews of PPC reliability and validity. We recommend monitoring of PPCs' reliability and validity in future years in response to changes in coding practices and improvements in hospital performance. For example, implementation of ICD-10 or changes in coding practice may affect measure properties. Performance improvements may affect the stability of norms used to standardize the measures and variation in hospitals' performance, which may in turn affect both noise and signal variance, and hence reliability.

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APPENDIX A

STATISTICAL METHODS FOR RELIABILITY TESTING

From the definition of PPC performance metrics used for the MHAC program, a PPC rate for hospital j can be formulated as

$$r_j = \frac{O_j}{E_j} = \frac{\sum_{i \in C_j} \sum_{k=1}^{n_{ij}} X_{j,k}^{(i)}}{\sum_{i \in C_j} n_{ij} \cdot N_i},$$

where C_j is the list of all categories associated with hospital j , n_{ij} is the number of at-risk discharges in APR-DRG SOI (All Patient Refined Diagnosis Related Group and severity of illness) category i in the performance period, $X_{j,k}^{(i)}$ is the PPC status (1 = yes, 0 = no) for discharge k in category i and hospital j , and N_i is the norm PPC rate for APR-DRG SOI category i , which is determined based on the base period data.

We use a signal-to-noise framework in reliability testing for the PPCs. Specifically, for each PPC, we estimate the two components of variation that produce the PPC performance metric: between-provider variation (also known as signal variance) and within-provider variation (also known as noise variance). Conceptually, the ratio of the signal variances to noise variances determines how well the measures can discern the performance of one provider from the next. We estimate these components of variation through a two-stage modeling framework:

- **Within-provider variation.** For this component, we assume that discharges within each APR-DRG and SOI category i across all hospitals follow the same underlying risk of a PPC numerator event, i.e., they are Bernoulli trials with parameter N_i . Specifically, an at-risk case X from category i has probability N_i that it incurs a PPC (coded as 1) and probability $1 - N_i$ that it does not (coded as 0). Thus, the number of a hospital's PPC events within each APR-DRG and SOI category follows a binomial distribution,⁸ and based on this data-generating mechanism we can estimate the within-provider variation for each hospital (say, hospital j) as well as the overall within-provider variation, denoted as $Var_{within-hospital-j}$ and Var_{within} , respectively. The variation *within hospital* j 's performance metric (i.e., noise) is calculated as

$$\begin{aligned} Var_{within-hospital-j} &= Var(r_j) = \sum_{i \in C_j} \frac{1}{\left(\sum_{i \in C_j} n_{ij} \cdot N_i\right)^2} Var\left(\sum_{k=1}^{n_{ij}} X_{j,k}^{(i)}\right) \\ &= \sum_{i \in C_j} \frac{n_{ij} \cdot N_i \cdot (1 - N_i)}{\left(\sum_{i \in C_j} n_{ij} \cdot N_i\right)^2}. \end{aligned}$$

⁸ Another way to understand the model framework is to view the total count of a hospital's PPC events (for example, the total number of PPC 1 events for hospital A) as a pooled binomial distribution, where each binomial distribution represents the distribution of the PPC within certain APR-DRG and SOI categories.

The overall within-provider variation is calculated as the weighted average of hospital-specific variances: $Var_{within} = \frac{1}{n_{tot}} \sum_j n_j \cdot Var_{within-hospital-j}$, where $n_{tot} = \sum_j n_j$ is the total number of at-risk discharges in the performance period across all hospitals and the overall mean rate $mean_{oa}$ is calculated as a weighted average of each hospital's performance rate, so that $mean_{oa} = \frac{1}{n_{tot}} \sum_j n_j \cdot r_j$.

- **Between-provider variation.** For this component, we assume that the true performance of hospital j for each PPC measure, which is estimated by $\frac{O_j}{E_j}$ times the statewide PPC rate, follows a Beta distribution. We apply this model to derive the signal variance through a SAS macro (Adams 2009) using maximum likelihood estimation, denoted as $Var_{between-hospital}$:

$$Var_{between-hospital} = \frac{\alpha \cdot \beta}{(\alpha + \beta + 1)(\alpha + \beta)^2} \cdot \frac{1}{statewide\ rate^2}.$$

Using these results, the reliability estimate for the PPC measure is calculated as

$$reliability = \frac{Var_{between-hospital}}{Var_{between-hospital} + Var_{within}},$$

and the reliability estimate of such a PPC measure for hospital j is calculated as

$$reliability\ for\ hospital\ j = \frac{Var_{between-hospital}}{Var_{between-hospital} + Var_{within-hospital-j}}.$$

APPENDIX B

RELIABILITY OF PPCS

PPC	Description	Tier	Number of hospitals meet PPC inclusion threshold	Reliability	Minimum hospital reliability	Maximum hospital reliability
1	Stroke & Intracranial Hemorrhage	C	42	0.417	0.093	0.821
2	Extreme CNS Complications	C	31	0.349	0.178	0.662
3	Acute Pulmonary Edema and Respiratory Failure Without Ventilation	A	45	0.877	0.381	0.981
4	Acute Pulmonary Edema and Respiratory Failure with Ventilation	A	45	0.710	0.156	0.950
5	Pneumonia & Other Lung Infections	A	45	0.728	0.277	0.938
6	Aspiration Pneumonia	A	45	0.653	0.204	0.864
7	Pulmonary Embolism	A	43	0.614	0.177	0.874
8	Other Pulmonary Complications	B	40	0.663	0.242	0.965
9	Shock	A	44	0.790	0.333	0.961
10	Congestive Heart Failure	B	41	0.873	0.568	0.959
11	Acute Myocardial Infarction	B	45	0.600	0.165	0.859
12	Cardiac Arrhythmias & Conduction Disturbances	C	9	0.958	0.909	0.979
13	Other Cardiac Complications	C	33	0.759	0.553	0.919
14	Ventricular Fibrillation/Cardiac Arrest	A	45	0.545	0.098	0.843
15	Peripheral Vascular Complications Except Venous Thrombosis	C	29	0.067	0.025	0.218
16	Venous Thrombosis	A	41	0.738	0.379	0.904
17	Major Gastrointestinal Complications Without Transfusion or Significant Bleeding	B	41	0.344	0.131	0.686
18	Major Gastrointestinal Complications with Transfusion or Significant Bleeding	B	38	0.104	0.039	0.217
19	Major Liver Complications	B	34	0.422	0.211	0.729
20	Other Gastrointestinal Complications Without Transfusion or Significant Bleeding	C	34	0.000	0.000	0.001
21	Clostridium Difficile Colitis	C	45	0.811	0.344	0.943
23	GU Complications Except UTI	C	39	0.619	0.311	0.877
24	Renal Failure Without Dialysis	A	45	0.847	0.469	0.958
25	Renal Failure with Dialysis	C	29	0.265	0.005	0.638

PPC	Description	Tier	Number of hospitals meet PPC inclusion threshold	Reliability	Minimum hospital reliability	Maximum hospital reliability
26	Diabetic Ketoacidosis & Coma	C	6	0.197	0.009	0.472
27	Post-Hemorrhagic & Other Acute Anemia with Transfusion	B	43	0.621	0.201	0.895
28	In-Hospital Trauma and Fractures	A	30	0.468	0.339	0.681
29	Poisonings Except from Anesthesia	C	33	0.395	0.229	0.631
30	Poisonings due to Anesthesia	C	46	NA ^a	NA	NA
31	Decubitus Ulcer	A	46	0.786	0.072	0.953
32	Transfusion Incompatibility Reaction	C	46	0.598	0.038	0.854
33	Cellulitis	C	40	0.339	0.118	0.707
34	Moderate Infections	C	32	0.319	0.146	0.659
35	Septicemia & Severe Infections	A	45	0.881	0.469	0.978
36	Acute Mental Health Changes	C	35	0.649	0.353	0.860
37	Post-Operative Infection & Deep Wound Disruption Without Procedure	A	42	0.485	0.094	0.871
38	Post-Operative Wound Infection & Deep Wound Disruption with Procedure	A	23	0.091	0.038	0.338
39	Reopening Surgical Site	C	26	0.597	0.343	0.854
40	Post-Operative Hemorrhage & Hematoma Without Hemorrhage Control Procedure or I&D Procedure	A	45	0.770	0.139	0.963
41	Post-Operative Hemorrhage & Hematoma with Hemorrhage Control Procedure or I&D Procedure	B	27	0.712	0.414	0.949
42	Accidental Puncture/Laceration During Invasive Procedure	A	43	0.810	0.341	0.966
43	Accidental Cut or Hemorrhage During Other Medical Care	C	11	0.767	0.045	0.981
44	Other Surgical Complication—Moderate	C	33	0.062	0.020	0.198
45	Post-Procedure Foreign Bodies	C	45	0.065	0.003	0.326
46	Post-Operative Substance Reaction & Non-O.R. Procedure for Foreign Body	C	46	0.268	0.018	1.000
47	Encephalopathy	C	38	0.780	0.494	0.941
48	Other Complications of Medical Care	B	41	0.598	0.271	0.867
49	Iatrogenic Pneumothorax	A	39	0.462	0.208	0.729

PPC	Description	Tier	Number of hospitals meet PPC inclusion threshold	Reliability	Minimum hospital reliability	Maximum hospital reliability
50	Mechanical Complication of Device, Implant & Graft	C	39	0.417	0.153	0.759
51	Gastrointestinal Ostomy Complications	C	37	0.369	0.190	0.646
52	Inflammation & Other Complications of Devices, Implants or Grafts Except Vascular Infection	C	44	0.681	0.209	0.911
53	Infection, Inflammation & Clotting Complications of Peripheral Vascular Catheters & Infusions	C	36	0.657	0.368	0.873
54	Infections due to Central Venous Catheters	A	33	0.536	0.287	0.856
55	Obstetrical Hemorrhage Without Transfusion	C	32	0.893	0.616	0.970
56	Obstetrical Hemorrhage with Transfusion	C	32	0.763	0.443	0.928
57	Obstetric Lacerations & Other Trauma Without Instrumentation	C	32	0.827	0.434	0.949
58	Obstetric Lacerations & Other Trauma With Instrumentation	C	31	0.756	0.431	0.930
59	Medical & Anesthesia Obstetric Complications	C	32	0.584	0.168	0.858
60	Major Puerperal Infection and Other Major Obstetric Complications	C	27	0.118	0.039	0.353
61	Other Complications of Obstetrical Surgical & Perineal Wounds	C	31	0.634	0.312	0.886
62	Delivery with Placental Complications	C	32	0.638	0.311	0.861
63	Post-Operative Respiratory Failure with Tracheostomy	C	11	0.229	0.002	0.783
64	Other In-Hospital Adverse Events	C	42	0.965	0.491	0.992
65	Urinary Tract Infection Without Catheter	A	45	0.744	0.261	0.934
66	Catheter-Related Urinary Tract Infection	A	35	0.767	0.527	0.928
67	Combined PPC (PPC 25, 26, 43, 63, 64)	C	44	0.932	0.667	0.986

Source: Calculations use FY 2014 data as base period and pooled FY 2014 and 2015 data as performance period.

^a The PPC 30 event is so rare in the performance period that its reliability cannot be evaluated based on the data.

NA = not available.

APPENDIX C

CORRELATIONS OF PPC MEASURES OVER TIME
(CY 2012 THROUGH SECOND QUARTER OF CY 2015)

			CY 2012 and CY 2013		CY 2013 and CY 2014		CY 2014 and CY 2015 quarters 1 and 2	
PPC	Description	Tier	Correlation	Statistically significant ^a	Correlation	Statistically significant	Correlation	Statistically significant
1	Stroke & Intracranial Hemorrhage	C	0.332	YES	0.317	YES	0.148	NO
2	Extreme CNS Complications	C	0.201	NO	0.219	NO	0.127	NO
3	Acute Pulmonary Edema and Respiratory Failure Without Ventilation	A	0.503	YES	0.388	YES	0.644	YES
4	Acute Pulmonary Edema and Respiratory Failure with Ventilation	A	0.530	YES	0.491	YES	0.404	YES
5	Pneumonia & Other Lung Infections	A	0.239	NO	0.469	YES	0.171	NO
6	Aspiration Pneumonia	A	0.672	YES	0.467	YES	0.583	YES
7	Pulmonary Embolism	A	0.402	YES	0.442	YES	0.432	YES
8	Other Pulmonary Complications	B	0.779	YES	0.065	NO	0.255	NO
9	Shock	A	0.452	YES	0.584	YES	0.346	YES
10	Congestive Heart Failure	B	0.762	YES	0.855	YES	0.710	YES
11	Acute Myocardial Infarction	B	0.639	YES	0.509	YES	0.194	NO
12	Cardiac Arrhythmias & Conduction Disturbances	C	0.934	YES	0.643	NO	0.948	YES
13	Other Cardiac Complications	C	0.695	YES	0.280	NO	0.652	YES
14	Ventricular Fibrillation/Cardiac Arrest	A	0.430	YES	0.485	YES	0.241	NO
15	Peripheral Vascular Complications Except Venous Thrombosis	C	-0.074	NO	0.133	NO	-0.085	NO
16	Venous Thrombosis	A	0.563	YES	0.610	YES	0.410	YES

			CY 2012 and CY 2013		CY 2013 and CY 2014		CY 2014 and CY 2015 quarters 1 and 2	
PPC	Description	Tier	Correlation	Statistically significant ^a	Correlation	Statistically significant	Correlation	Statistically significant
17	Major Gastrointestinal Complications Without Transfusion or Significant Bleeding	B	0.282	NO	0.229	NO	0.162	NO
18	Major Gastrointestinal Complications with Transfusion or Significant Bleeding	B	0.259	NO	0.075	NO	-0.086	NO
19	Major Liver Complications	B	0.449	YES	0.546	YES	0.457	YES
20	Other Gastrointestinal Complications Without Transfusion or Significant Bleeding	C	-0.207	NO	-0.247	NO	0.290	NO
21	Clostridium Difficile Colitis	C	0.707	YES	0.591	YES	0.442	YES
23	GU Complications Except UTI	C	0.513	YES	0.355	YES	0.298	NO
24	Renal Failure Without Dialysis	A	0.606	YES	0.324	YES	0.505	YES
27	Post-Hemorrhagic & Other Acute Anemia with Transfusion	B	0.422	YES	0.256	NO	0.219	NO
28	In-Hospital Trauma and Fractures	A	0.057	NO	0.184	NO	0.081	NO
29	Poisonings Except from Anesthesia	C	0.211	NO	0.061	NO	-0.180	NO
30	Poisonings due to Anesthesia	C	NA ^b	NA	NA	NA	NA	NA
31	Decubitus Ulcer	A	0.196	NO	0.032	NO	0.191	NO
32	Transfusion Incompatibility Reaction	C	-0.027	NO	NA	NA	NA	NA
33	Cellulitis	C	0.147	NO	0.192	NO	-0.039	NO
34	Moderate Infections	C	0.355	YES	0.283	NO	0.095	NO

			CY 2012 and CY 2013		CY 2013 and CY 2014		CY 2014 and CY 2015 quarters 1 and 2	
PPC	Description	Tier	Correlation	Statistically significant ^a	Correlation	Statistically significant	Correlation	Statistically significant
35	Septicemia & Severe Infections	A	0.607	YES	0.484	YES	0.544	YES
36	Acute Mental Health Changes	C	0.734	YES	0.769	YES	0.681	YES
37	Post-Operative Infection & Deep Wound Disruption Without Procedure	A	0.490	YES	0.464	YES	0.297	NO
38	Post-Operative Wound Infection & Deep Wound Disruption with Procedure	A	0.121	NO	0.004	NO	0.017	NO
39	Reopening Surgical Site	C	0.277	NO	0.388	NO	0.381	NO
40	Post-Operative Hemorrhage & Hematoma Without Hemorrhage Control Procedure or I&D Procedure	A	0.429	YES	0.276	NO	0.525	YES
41	Post-Operative Hemorrhage & Hematoma with Hemorrhage Control Procedure or I&D Procedure	B	0.345	NO	0.423	YES	0.452	YES
42	Accidental Puncture/Laceration During Invasive Procedure	A	0.473	YES	0.240	NO	0.402	YES
44	Other Surgical Complication—Moderate	C	0.334	NO	0.102	NO	0.091	NO
45	Post-Procedure Foreign Bodies	C	0.194	NO	0.075	NO	-0.049	NO
46	Post-Operative Substance Reaction & Non-O.R. Procedure for Foreign Body	C	0.874	YES	-0.038	NO	-0.040	NO
47	Encephalopathy	C	0.646	YES	0.578	YES	0.265	NO
48	Other Complications of Medical Care	B	0.464	YES	0.423	YES	0.382	YES

			CY 2012 and CY 2013		CY 2013 and CY 2014		CY 2014 and CY 2015 quarters 1 and 2	
PPC	Description	Tier	Correlation	Statistically significant ^a	Correlation	Statistically significant	Correlation	Statistically significant
49	Iatrogenic Pneumothorax	A	0.428	YES	0.176	NO	-0.248	NO
50	Mechanical Complication of Device, Implant & Graft	C	0.339	YES	0.050	NO	0.397	YES
51	Gastrointestinal Ostomy Complications	C	0.325	YES	0.098	NO	0.017	NO
52	Inflammation & Other Complications of Devices, Implants or Grafts Except Vascular Infection	C	0.506	YES	0.133	NO	0.399	YES
53	Infection, Inflammation & Clotting Complications of Peripheral Vascular Catheters & Infusions	C	0.552	YES	0.518	YES	0.281	NO
54	Infections due to Central Venous Catheters	A	0.344	YES	0.181	NO	0.037	NO
55	Obstetrical Hemorrhage Without Transfusion	C	0.764	YES	0.567	YES	0.585	YES
56	Obstetrical Hemorrhage with Transfusion	C	0.754	YES	0.462	YES	0.473	YES
57	Obstetric Lacerations & Other Trauma Without Instrumentation	C	0.707	YES	0.748	YES	0.713	YES
58	Obstetric Lacerations & Other Trauma With Instrumentation	C	0.580	YES	0.393	YES	0.352	NO
59	Medical & Anesthesia Obstetric Complications	C	0.435	YES	0.208	NO	0.361	YES
60	Major Puerperal Infection and Other Major Obstetric Complications	C	0.553	YES	-0.054	NO	0.144	NO

			CY 2012 and CY 2013		CY 2013 and CY 2014		CY 2014 and CY 2015 quarters 1 and 2	
PPC	Description	Tier	Correlation	Statistically significant ^a	Correlation	Statistically significant	Correlation	Statistically significant
61	Other Complications of Obstetrical Surgical & Perineal Wounds	C	0.677	YES	0.469	YES	0.235	NO
62	Delivery with Placental Complications	C	0.727	YES	0.348	NO	0.286	NO
65	Urinary Tract Infection Without Catheter	A	0.435	YES	0.518	YES	0.472	YES
66	Catheter-Related Urinary Tract Infection	A	0.362	YES	0.228	NO	0.625	YES
67	Combined PPC (PPC 25, 26, 43, 63, 64)	C	0.815	YES	0.493	YES	0.696	YES

Source: Calculation of norms uses FY 2014 data as base period for all performance periods. .

^a alpha = 0.05

^b The PPC event is so rare in at least one of the performance periods that the correlation cannot be calculated based on the data.

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APPENDIX V.

HSCRC STAFF RECOMMENDATIONS FOR FY 2018 PPC TIERS, COMBINATIONS, AND EXCLUSIONS

The following table displays recommendations for the FY 2018 PPC tiers, combinations, and exclusions. The first two columns of the table display the PPC number and description, as classified by 3M. The third column displays the total number of cases for the PPC in CY 2014. For example, the first row of the table shows that there were 1,054 cases with acute pulmonary edema and respiratory failure without ventilation statewide in CY 2014. The fourth column shows the tier (1-3) for each PPC in FY 2017. The fifth column shows the Maryland Hospital Association's recommendations on which PPCs should be classified as tier 1 in FY 2018; these recommendations are indicated with a "Y." Columns six and seven indicate the PPCs that Mathematic classified as having low reliability or low stability; these are indicated with a "Y." Column eight presents Mathematica's recommendation for each measure for FY 2018. Column nine presents 3M's comments on Mathematica's recommendations; blank cells indicate that 3M had no comment. Column ten presents recommendations submitted by Lifebridge Health. Finally, column 11 presents HSCRC staff's final recommendations for FY 2018.

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
3	Acute Pulmonary Edema and Respiratory Failure without Ventilation	1,054	1	Y			Keep in Tier 1			Tier 1
4	Acute Pulmonary Edema and Respiratory Failure with Ventilation	637	1	Y			Keep in Tier 1			Tier 1
5	Pneumonia & Other Lung Infections	674	1	Y			Keep in Tier 1			Tier 1
6	Aspiration Pneumonia	496	1	Y			Keep in Tier 1			Tier 1
7	Pulmonary Embolism	304	1	Y			Keep in Tier 1			Tier 1

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
9	Shock	512	1				Keep in Tier 1. Has good reliability and stability.			Tier 1
14	Ventricular Fibrillation/ Cardiac Arrest	975	1	Y			Keep in Tier 1			Tier 1
16	Venous Thrombosis	411	1				Keep in Tier 1; Has good reliability and stability.		Agree to keep in Tier 1; Clinically disagree with combining with PPC 15. A thrombus in a vein shouldn't be compared to a thrombus in a device. Treatment and clinical risk are not the same; High risk for thrombus traveling through the vascular system to the brain, lung etc. Treatment is long term anticoagulation	Tier 1. Do not combine with PPC 15.
21	Clostridium Difficile Colitis	610	3	Y			Move to Tier 1. 32 hospitals have this PPC. On the low end of hospitals for Tier 1, but similar to some of the PPCs. Measure is reliable and stable. Benchmarks are reasonably high and performance mixed so room for improvement.			Tier 1

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
27	Post-Hemorrhagic & Other Acute Anemia with Transfusion	503	2	Y			Move to Tier 1. Recommended by MHA and stable and reliable.		With the change to ICD 10, the definition parameters have changed; thus the definition needs to be modified to reflect appropriate timing of transfusion; prior to this PPC moving to Tier 1. This is a timing issue with transfusion. Even when the transfusion takes place within a day or two of the surgery, any subsequent transfusions will trigger the PPC.	Tier 1
35	Septicemia & Severe Infections	507	1	Y			Keep in Tier 1			Tier 1
37	Post-Operative Infection & Deep Wound Disruption Without Procedure	378	1	Y			Keep in Tier 1			Tier 1
38	Post-Operative Wound Infection & Deep Wound Disruption with Procedure	33	1		Y	Y	Suggest to drop from MHAC due to low reliability and stability	Disagree – serious complication		Tier 1

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
40	Post-Operative Hemorrhage & Hematoma without Hemorrhage Control Procedure or I&D Procedure	920	1	Y			Keep in Tier 1			Tier 1
41	Post-Operative Hemorrhage & Hematoma with Hemorrhage Control Procedure or I&D Proc	130	2	Y			Move to Tier 1. Recommended by MHA and stable and reliable. However, only relevant to 27 hospitals.		Agree with moving to Tier 1 for clinical significance. However, hospitals that perform major surgeries on complex cases will be negatively impacted. It may make sense to evaluate separate benchmarks for major surgery.	Tier 1
42	Accidental Puncture/Laceration During Invasive Procedure	458	1				Keep in Tier 1. Has good reliability and stability.			Tier 1
49	Iatrogenic Pneumothorax	118	1				Keep in Tier 1. Has good reliability and stability.			Tier 1
54	Infections due to Central Venous Catheters	95	1				Keep in Tier 1. Has good reliability and stability			Tier 1
65	Urinary Tract Infection without Catheter	1,036	1	Y			Keep in Tier 1			Tier 1
66	Catheter-Related Urinary Tract Infection	114	1				Keep in Tier 1. Has good reliability and stability.			Tier 1

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
1	Stroke & Intracranial Hemorrhage	369	3				Tier 2			Tier 2
2	Extreme CNS Complications	77	3		Y	Y	Add to combined PPC with other measures. Put combined measure in Tier 2.	Disagree with combining with another PPC for a new "measure." Most are sentinel events or nearly so.		Monitor
8	Other Pulmonary Complications	348	2				Tier 2			Tier 2
10	Congestive Heart Failure	271	2				Tier 2			Tier 2
11	Acute Myocardial Infarction	430	2				Tier 2			Tier 2
12	Cardiac Arrhythmias & Conduction Disturbances	359	3				Tier 2			Tier 2
13	Other Cardiac Complications	94	3				Tier 2			Tier 2
15	Peripheral Vascular Complications Except Venous Thrombosis	83	3		Y	Y	Drop from MHAC due to low reliability and stability	Disagree with dropping. These are serious complications and should be tracked	Agree with Mathematica for dropping. This usually stems from a clotted vascular line and not a serious occurrence. Treatment involves a clot dissolving medication to be infused into the line. The line is then usable; or if not, the line can simply be removed, thus a low risk for an untoward	Monitor

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
									patient event. No ongoing treatment once resolved. In the event it cannot be dropped, we do not agree combining PPCs 15 and 16. PPC 15 is of low reliability and currently in Tier 3. This combination would move it to Tier 1 and give it higher significance than clinically warranted; also prevention and treatment are not equivalent.	
17	Major Gastrointestinal Complications without Transfusion or Significant Bleeding	209	2		Y	Y	Add to combined PPC with other measures with low reliability and stability over time. Put combined measure in Tier 2.	Could understand moving this to the lowest Tier	Agree with HSCRC to combine 17 & 18, as these are clinically similar conditions.	Tier 2 Combine 17, 18 for scoring. Report cases separately.
18	Major Gastrointestinal Complications with Transfusion or Significant Bleeding	98	2		Y	Y	Suggest drop from MHAC due to low reliability and stability	Serious complications (in-hospital bleeding requiring transfusion)	Agree with Mathematica to drop to a low tier. Although a major GI bleed is serious, it is usually due to unpreventable conditions. It is also likely to be present on admission, but hard to establish onset and etiology.	Tier 2. Combine 17, 18 for scoring. Report cases separately.
19	Major Liver Complications	105	2				Tier 2		Disagree that this should be combined with 17 & 18. Although they are all the GI system, PPC 20 is usually from a bowel obstruction and not a bleeding situation.	Tier 2

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
20	Other Gastrointestinal Complications without Transfusion or Significant Bleeding	129	3		Y	Y	Suggest drop from MHAC due to low reliability and stability	Could understand moving this to the lowest Tier.		Monitor
23	GU Complications Except UTI	129	3				Tier 2			Tier 2
24	Renal Failure without Dialysis	1,760								
25	Renal Failure with Dialysis	32								Tier 2. Currently Combined PPC 67 (PPC 25, 26, 43, 63, 64). Report cases separately.
26	Diabetic Ketoacidosis & Coma	12								Tier 2. Currently Combined PPC 67 (PPC 25, 26, 43, 63, 64). Report cases separately.
28	In-Hospital Trauma and Fractures	59	1			Y	Move to Tier 2. Lower reliability as well			Tier 2.
29	Poisonings Except from Anesthesia	71	3		Y	Y	Add to combined PPC with other measures with low reliability and stability over time. Put combined measure in	Keep these in the current category as they represent sentinel		Monitor

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
							Tier 2.	events		
30	Poisonings due to Anesthesia	0	3			Y	Tier 2			Tier 2. Never Event.
31	Decubitus Ulcer	75	1			Y	Move to Tier 2- does not have low reliability but is not stable and not recommended by MHA.			Tier 2. Never Event.
32	Transfusion Incompatibility Reaction	0	3			Y	Tier 2			Tier 2. Never Event.
33	Cellulitis	195	3		Y	Y	Add to combined PPC with other measures with low reliability and stability over time. Put combined measure in Tier 2.	Could combine PPC 33 with PPC 34 Moderate Infections, since they are clinically compatible	Want to see this modeled before agreeing to combine these; they are different enough that it might not make clinical sense.	Monitor
34	Moderate Infectious	87	3		Y		Add to combined PPC with other measures with low reliability and stability over time. Put combined measure in Tier 2.	Could combine PPC 33 with PPC 34 Moderate Infections, since they are clinically compatible		Tier 2
36	Acute Mental Health Changes	123	3				Tier 2			Tier 2
39	Reopening Surgical Site	103	3			Y	Tier 2			Tier 2

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
43	Accidental Cut or Hemorrhage During Other Medical Care	27								Tier 2. Currently Combined PPC 67 (PPC 25, 26, 43, 63, 64). Report cases separately.
44	Other Surgical Complication - Mod	105	3		Y	Y	Suggest drop from MHAC due to low reliability and stability	Disagree with dropping. Could understand moving this to the lowest Tier.		Tier 2
45	Post-procedure Foreign Bodies	18	3			Y	Tier 2			Tier 2. Never Event.
46	Post-Operative Substance Reaction & Non-O.R. Procedure for Foreign Body	2	3				Tier 2			Tier 2. Never Event.
47	Encephalopathy	132	3				Tier 2			Tier 2
48	Other Complications of Medical Care	242	2				Tier 2			Tier 2
50	Mechanical Complication of Device, Implant & Graft	187	3				Tier 2			Tier 2
51	Gastrointestinal Ostomy Complications	94	3		Y		Tier 2			Tier 2

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
52	Inflammation & Other Complications of Devices, Implants or Grafts Except Vascular Infection	381	3				Tier 2			Tier 2
53	Infection, Inflammation & Clotting Complications of Peripheral Vascular Catheters & Infusions	139	3				Tier 2			Tier 2

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
55	Obstetrical Hemorrhage without Transfusion	1,033	3	Y			Move to Tier 1. 32 hospitals have this PPC. On the low end of hospitals for Tier 1 but similar to some of the PPCs. Measure is reliable and stable. Benchmarks are reasonably high and performance mixed so room for improvement.		Disagree clinically with moving to tier 1. Condition is frequently not reflective of a quality of care issue. The provider cannot control the mother's response to labor and delivery. This condition is frequently recognized early and immediate measures are taken to prevent a hemorrhage from occurring. Bleeding is often described as small amount, minimal, and not clinically a hemorrhage. These are documentation and coding guideline issues; not quality of care issues. For the obstetric PPCs in general, consideration must also be given to the fact that these PPCs are not applicable to all hospitals, thus the impact is not evenly distributed. Moreover, obstetric PPC' are not included in the CMS HAC program, thus are not a focus outside Maryland.	Tier 2. Combine PPCs 55, 56 for scoring. Report separately.

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
56	Obstetrical Hemorrhage with Transfusion	494	3	Y			Move to Tier 1. 32 hospitals have this PPC. On the low end of hospitals for Tier 1 but similar to some of the PPCs. Measure is reliable and stable. Benchmarks are reasonably high and performance mixed so room for improvement.		: Disagree clinically with moving to tier 1. Condition is frequently not reflective of a quality of care issue. The provider cannot control the mother's response to labor and delivery. This condition is frequently recognized early and immediate measures are taken to prevent a hemorrhage from occurring. Revisit the definition to include only c-sections to trigger the PPC because this is the population in which this is clinically significant.	Tier 2. Combine PPCs 55, 56 for scoring. Report separately.
57	Obstetric Lacerations & Other Trauma Without Instrumentation	891	3				Tier 2			Tier 2. Combine PPCs 57, 58 for scoring. Report separately.
58	Obstetric Lacerations & Other Trauma With Instrumentation	304	3				Tier 2			Tier 2. Combine PPCs 57, 58 for scoring. Report separately.

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
59	Medical & Anesthesia Obstetric Complications	328	3				Tier 2		Recommend combining the following obstetric PPCs: 59, 60, 61 and 62. These are generally very low volume and combining them into one "other OB complications" group would create more stability.	Tier 2
60	Major Puerperal Infection and Other Major Obstetric Complications	74	3		Y		Drop from MHAC due to low reliability	Disagree with dropping. Serious and significant complications (equivalent to sentinel events)	Recommend combining the following Obstetric PPCs: 59, 60, 61 and 62. These are generally very low volume and combining them into one "other OB complications" group would create more stability.	Tier 2
61	Other Complications of Obstetrical Surgical & Perineal Wounds	137	3				Tier 2		Recommend combining the following Obstetric PPCs: 59, 60, 61 and 62. These are generally very low volume and combining them into one "other OB complications" group would create more stability.	Tier 2

1. PPC #	2. PPC Description	3. Observed # of Cases	4. FY17 Tier	5. MHA FY18 Tier 1 Recs.	6. Low Reliability	7. Low Stability	8. Mathematica FY18 Recommendations	9. 3M FY18 Recommendations	10. Lifebridge FY18 Recommendations	11. HSCRC FY18 Recommendations
62	Delivery with Placental Complications	172	3				Tier 2		Recommend combining the following Obstetric PPCs: 59, 60, 61 and 62. These are generally very low volume and combining them into one "other OB complications" group would create more stability.	Tier 2
63	Post-Operative Respiratory Failure with Tracheostomy	24					Tier 2			Tier 2. Currently Combined PPC 67 (PPC 25, 26, 43, 63, 64). Report cases separately.
64	Other In-Hospital Adverse Events	255					Tier 2			Tier 2. Currently Combined PPC 67 (PPC 25, 26, 43, 63, 64). Report cases separately.
67	Combined PPC* (PPC 25, 26, 43, 63, 64)		3				Tier 2		Consider placing low volume PPCs such as 28, 29, 30 and 32 in PPC 67.	Tier 2. Currently Combined PPC 67 (PPC 25, 26, 43, 63, 64). Report cases separately.

APPENDIX VI.

FY 2017 CONTINGENT SCALING PRESET SCORES, AND YEAR TO DATE RESULTS

Final MHAC Score		Below State Quality Target	Exceed State Quality Target
Scores less than or equal to	0.17	-3.00%	-1.00%
	0.18	-2.91%	-0.96%
	0.19	-2.82%	-0.92%
	0.20	-2.74%	-0.88%
	0.21	-2.65%	-0.83%
	0.22	-2.56%	-0.79%
	0.23	-2.47%	-0.75%
	0.24	-2.38%	-0.71%
	0.25	-2.29%	-0.67%
	0.26	-2.21%	-0.63%
	0.27	-2.12%	-0.58%
	0.28	-2.03%	-0.54%
	0.29	-1.94%	-0.50%
	0.30	-1.85%	-0.46%
	0.31	-1.76%	-0.42%
	0.32	-1.68%	-0.38%
	0.33	-1.59%	-0.33%
	0.34	-1.50%	-0.29%
	0.35	-1.41%	-0.25%
	0.36	-1.32%	-0.21%
	0.37	-1.24%	-0.17%
	0.38	-1.15%	-0.12%
	0.39	-1.06%	-0.08%
	0.40	-0.97%	-0.04%
	0.41	-0.88%	0.00%
	0.42	-0.79%	0.00%
	0.43	-0.71%	0.00%
	0.44	-0.62%	0.00%
	0.45	-0.53%	0.00%
	0.46	-0.44%	0.00%
	0.47	-0.35%	0.00%
	0.48	-0.26%	0.00%
	0.49	-0.18%	0.00%
	0.500	-0.09%	0.00%
	0.510	0.00%	0.03%
	0.52	0.00%	0.07%
	0.53	0.00%	0.10%
	0.54	0.00%	0.13%
	0.55	0.00%	0.17%
	0.56	0.00%	0.20%
	0.57	0.00%	0.23%
	0.58	0.00%	0.27%
	0.59	0.00%	0.30%
	0.60	0.00%	0.33%
	0.61	0.00%	0.37%
	0.62	0.00%	0.40%
	0.63	0.00%	0.43%
	0.64	0.00%	0.47%
	0.65	0.00%	0.50%
	0.66	0.00%	0.53%
	0.67	0.00%	0.57%
	0.68	0.00%	0.60%
	0.69	0.00%	0.63%
	0.70	0.00%	0.67%
	0.71	0.00%	0.70%
	0.72	0.00%	0.73%
	0.73	0.00%	0.77%
	0.74	0.00%	0.80%
	0.75	0.00%	0.83%
	0.76	0.00%	0.87%
	0.77	0.00%	0.90%
	0.78	0.00%	0.93%
	0.79	0.00%	0.97%
Scores greater than or equal to	0.80	0.00%	1.00%

Hospital Name	Estimated Inpatient Revenue (FY15*2.6%)	MHAC Base Year Scores	Score Change	MHAC YTD (Sept) Scores FY17	% Adjustment	\$ Adjustment
WASHINGTON ADVENTIST	\$161,698,669	0.34	0.01	0.35	-0.25%	\$ (404,247)
PRINCE GEORGE	\$177,243,165	0.50	(0.13)	0.37	-0.17%	\$ (295,405)
SOUTHERN MARYLAND	\$163,208,213	0.22	0.15	0.37	-0.17%	\$ (272,014)
JOHNS HOPKINS	\$1,292,515,919	0.24	0.15	0.39	-0.08%	\$ (1,077,097)
EASTON	\$94,828,132	0.45	(0.03)	0.42	0.00%	\$ -
WESTERN MARYLAND HEALTH SYSTEM	\$184,484,266	0.38	0.05	0.43	0.00%	\$ -
G.B.M.C.	\$201,533,345	0.25	0.18	0.43	0.00%	\$ -
MERITUS	\$187,434,497	0.36	0.08	0.44	0.00%	\$ -
DOCTORS COMMUNITY	\$136,225,391	0.32	0.12	0.44	0.00%	\$ -
LAUREL REGIONAL	\$77,501,975	0.39	0.06	0.45	0.00%	\$ -
ATLANTIC GENERAL	\$38,640,762	0.58	(0.13)	0.45	0.00%	\$ -
BON SECOURS	\$78,212,787	0.64	(0.18)	0.46	0.00%	\$ -
ANNE ARUNDEL	\$310,117,075	0.29	0.17	0.46	0.00%	\$ -
GOOD SAMARITAN	\$180,861,011	0.51	(0.03)	0.48	0.00%	\$ -
UNION MEMORIAL	\$242,505,500	0.28	0.21	0.49	0.00%	\$ -
SHADY GROVE	\$228,731,775	0.42	0.08	0.50	0.00%	\$ -
FREDERICK MEMORIAL	\$189,480,763	0.36	0.15	0.51	0.03%	\$ 63,160
MONTGOMERY GENERAL	\$87,652,208	0.38	0.14	0.52	0.07%	\$ 58,435
SUBURBAN	\$181,410,188	0.21	0.32	0.53	0.10%	\$ 181,410
HOWARD COUNTY	\$167,386,497	0.24	0.29	0.53	0.10%	\$ 167,386
CARROLL COUNTY	\$138,209,278	0.29	0.25	0.54	0.13%	\$ 184,279
MERCY	\$233,163,594	0.38	0.17	0.55	0.17%	\$ 388,606
CHARLES REGIONAL	\$76,338,049	0.59	(0.04)	0.55	0.17%	\$ 127,230
NORTHWEST	\$142,186,717	0.33	0.22	0.55	0.17%	\$ 236,978

Hospital Name	Estimated Inpatient Revenue (FY15*2.6%)	MHAC Base Year Scores	Score Change	MHAC YTD (Sept) Scores FY17	% Adjustment	\$ Adjustment
UMMC MIDTOWN	\$133,787,811	0.44	0.13	0.57	0.23%	\$ 312,172
UM ST. JOSEPH	\$216,335,128	0.34	0.23	0.57	0.23%	\$ 504,782
BALTIMORE WASHINGTON MEDICAL CENTER	\$223,155,126	0.30	0.28	0.58	0.27%	\$ 595,080
SINAI	\$429,154,679	0.33	0.26	0.59	0.30%	\$ 1,287,464
FRANKLIN SQUARE	\$285,691,170	0.38	0.22	0.60	0.33%	\$ 952,304
UNIVERSITY OF MARYLAND	\$863,843,449	0.25	0.36	0.61	0.37%	\$ 3,167,426
HOLY CROSS	\$319,596,342	0.21	0.40	0.61	0.37%	\$ 1,171,853
ST. AGNES	\$239,121,556	0.35	0.26	0.61	0.37%	\$ 876,779
UPPER CHESAPEAKE HEALTH	\$148,917,096	0.33	0.30	0.63	0.43%	\$ 645,307
UNION HOSPITAL OF CECIL COUNT	\$67,852,189	0.49	0.15	0.64	0.47%	\$ 316,644
HARBOR	\$124,002,220	0.35	0.29	0.64	0.47%	\$ 578,677
REHAB & ORTHO	\$69,104,846	0.47	0.17	0.64	0.47%	\$ 322,489
HOPKINS BAYVIEW MED CTR	\$356,396,901	0.54	0.11	0.65	0.50%	\$ 1,781,985
DORCHESTER	\$25,127,935	0.40	0.29	0.69	0.63%	\$ 159,144
PENINSULA REGIONAL	\$233,728,496	0.19	0.50	0.69	0.63%	\$ 1,480,280
ST. MARY	\$69,520,305	0.55	0.14	0.69	0.63%	\$ 440,295
HARFORD	\$47,089,618	0.47	0.26	0.73	0.77%	\$ 361,020
CHESTERTOWN	\$29,416,674	0.81	(0.06)	0.75	0.83%	\$ 245,139
CALVERT	\$67,385,287	0.47	0.28	0.75	0.83%	\$ 561,544
GARRETT COUNTY	\$18,724,074	0.50	0.28	0.78	0.93%	\$ 174,758
FT. WASHINGTON	\$17,776,133	0.55	0.33	0.88	1.00%	\$ 177,761
MCCREADY	\$3,734,618	1.00	-	1.00	1.00%	\$ 37,346