Detailed Release Changes: Reliability Weights for Version 4.1b

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None of the investigators has any affiliations or financial involvement that conflicts with the material presented in this document.

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Overview

Reliability weights are used in the calculation of the "smoothed" rates, which are a weighted average of the hospital risk-adjusted rate and the reference population rate. We revised the calculation of these weights to address the lower reliability weights in version 4.1 (December, 2009) for the provider level indicators and composite measures for the Inpatient Quality Indicators (IQI), the Patient Safety Indicators (PSI) and the Pediatric Quality Indicators (PDI). We refer to the updated reliability weights as version 4.1b (June, 2010).

This document describes the testing we conducted to ensure the accuracy of the updated reliability weights, the changes to the AHRQ Quality Indicators (AHRQ QI) SAS software needed to implement the updated reliability weights, and a summary of the changes made in the calculation of weights.

Reliability is defined as the ratio of the between-provider variation to the total variation (the sum of the within-provider and between-provider variation).

Testing of Reliability Weight Calculation

We tested the reliability weight calculation in the following manner:
- Implemented the algorithm to calculate the weights in two different software packages (SAS and Stata) and compared the results (results not shown)
- Compared the updated reliability weights to the weights previously reported in a prior version of the AHRQ QI software (Tables I.1 and S.1)
- Decomposed the reliability weights into the component parts (total variance, signal variance and noise variance) and examined the convergence of the parts associated with increasing denominator size (an example of this type of analysis is in Figure I.1)
- Calculated the updated signal variance and signal standard deviation (the square root of the variance) and the percent of providers with a 95% probability of being better or worse than the reference population rate for the individual indicators and the composites (Tables I.2 and S.2)
- Compared the updated signal variance to the signal variance computed using an alternative methodology based on computing the provider level covariance (Tables I.3 and S.3)

Comparison with Previous Version

Tables I.1 and S.1 compare the updated reliability weights to the weights reported in the IQI and PSI Composite Workgroup reports (using version 3 of the software). The tables show the overall reliability weight and the weights by hospital denominator size (by quartiles). In general, the updated reliability weights are slightly less than the previous weights, but of a similar magnitude. We expected a reduction in the reliability weights (i.e., a decrease in the signal and increase in the noise) because of the changes implemented in version 4.1. Specifically, a one-year reference population increases the likelihood that a provider with a "true" non-zero rate has a zero rate and the use of the present on admission data reduces indicator prevalence.

Decomposition of Components

The overall signal variance is a weighted average of the signal variance estimated at the provider level, where the weight is 1/(noise variance)^2. Because the noise variance is expected to decrease with increased provider denominator size, one can gain an intuition for the calculation of the reliability weights by examining the component parts (total variance, signal variance and noise variance) by hospital denominator size. An example of this type of analysis is shown in Figure I.1 for IQI #15 (AMI Mortality). For providers with smaller denominators (on the left of the graph) there is greater total variance, but a larger proportion of that variance is noise. For providers with larger denominators (on the right of the graph) there is lesser total variance, but a larger proportion of that variance is signal. The estimated signal variance is about the same regardless of provider denominator size.

Signal Variance and Discrimination

Tables I.2 and S.2 compare the signal variance and signal standard deviation between version 4.1 and version 4.1b. In general, the signal variance is greater in the updated estimates. The resulting improvement in reliability increases the probability that providers will be better or worse than the reference population rate (called discrimination). The composites improve on the reliability of the individual indicators by increasing the effective sample size, which increases the ability of the composite measures to discriminate provider performance.

Using an Alternative Methodology

Finally, we tested the accuracy of the reliability weights by computing the signal variance using an alternative methodology (Tables I.3 and S.3). We randomly assigned patients to Group 1 and Group 2 and computed a provider level risk-adjusted rate for each group. We then calculated the correlation (and covariance) in the provider level risk-adjusted rate. Because the noise variance is not correlated with the provider, the resulting covariance is the signal. The resulting signal variance is essentially identical to the current AHRQ QI methodology (for the resection method, the alternative methodology excludes more providers with small denominators which increases the signal).

Changes to the Software to Implement the Updated Weights

This section describes the changes that were made to the AHRQ QI SAS software for version 4.1b. To apply the updated reliability weights, we substituted the MSX text files currently provided with the software with updated version labeled as "41B". We also changed the filename reference in the applicable CONTROL.SAS program as is indicated below. In addition, we modified the P3 program as the updated reliability weights are based on a proportional recalibration of the patient level predicted rate rather than a difference recalibration. The proportional recalibration is more consistent with the current method of indirect standardization

(which uses a proportional observed-to-expected ratio as the provider estimate). Because both the difference and proportional recalibrations are monotonic transformations of the estimated predicted rate, the model performance (i.e., the c-statistic) is identical. However, the difference recalibration understates the variance in the expected rate, which overstates the variance in the risk-adjusted rate. Therefore the proportional recalibration is the more *conservative* estimator for reliability, which is why we recommend adoption of this approach.

Inpatient Quality Indicators

1. CONTROL_IQI.SAS

Change:
```
FILENAME MSXP "C:\PATHNAME\MSXIQP41.TXT"; *<===USER MUST modify;
```
To:
```
FILENAME MSXP "C:\PATHNAME\MSXIQP41B.TXT"; *<===USER MUST modify;
```

2. IQSASP3.SAS

Change:
```
EHAT = ARRYP4(SUB_N) + Y_X_P_0_MCMC;
```
To:
```
EHAT = (ARRYP3(SUB_N)/(ARRYP3(SUB_N)-ARRYP4(SUB_N))) * Y_X_P_0_MCMC;
```

3. IQI_COMPOSITE.SAS

Change:
```
FILENAME MSXC "C:\PATHNAME\MSXIQC41.TXT";
```
To:
```
FILENAME MSXC "C:\PATHNAME\MSXIQC41B.TXT";
```

Patient Safety Indicators

1. CONTROL_PSI.SAS

Change:
```
FILENAME MSXP "C:\PATHNAME\MSXPSP41.TXT"; *<===USER MUST modify;
```
To:
```
FILENAME MSXP "C:\PATHNAME\MSXPSP41B.TXT"; *<===USER MUST modify;
```

2. PSSASP3.SAS

Change:
```
EHAT = ARRYP4(SUB_N) + Y_X_P_0_MCMC;
```
To:
```
EHAT = (ARRYP3(SUB_N)/(ARRYP3(SUB_N)-ARRYP4(SUB_N))) * Y_X_P_0_MCMC;
```

3. PSI_COMPOSITE.SAS

Change:
```
FILENAME MSXC "C:\PATHNAME\MSXPSC41.TXT";
```
To:
```
FILENAME MSXC "C:\PATHNAME\MSXPSC41B.TXT";
```

Changes in the Calculation of the Reliability Weights

The following summarizes the changes made to the calculation in the reliability weights from version 4.1 to version 4.1b.

1. We replaced PROC IMPORT in SAS with the auto-generated data step syntax when importing the comma-delimited output files from the MCMC prediction module. A new step in the computation of the reliability weights in version 4.1 was the prediction module and the CSV output files containing the results of the estimation. PROC IMPORT estimates the data formats by reading the first 32,000 records (the default). Because the CSV files may contain several million records, the PROC IMPORT underestimated the length of the provider identifier in about 10% of the providers. The resulting pooling of the discharge records increased the noise variance and decreased the signal variance, reducing the reliability weights.
2. We adopted the proportional recalibration discussed above.
3. We changed the computation of the weighted average of the signal variance from Mean(Total-Noise) to Mean(Total)-Mean(Noise). This allowed for the decomposition analysis discussed above and shown in Figure I.1.

Inpatient Quality Indicators

Table I1. Reliability weights compared to composite workgroup report

AHRQ QI	IQI Composite Workgroup Report					Version 4.1b (June, 2010)				
	Q1	Q2	Q3	Q4	Weighted Average	Q1	Q2	Q3	Q4	Weighted Average
IQI #08 In-Hosp Mort Esophageal Resection	0.0306	0.0450	0.0623	0.1551	0.1565	0.0356	0.0595	0.1077	0.3500	0.2672
IQI #09 In-Hosp Mort Pancreatic Resection	0.0230	0.0313	0.0496	0.1196	0.1421	0.0171	0.0388	0.0679	0.2920	0.2262
IQI #11 In-Hosp Mort AAA Repair	0.0446	0.0942	0.1666	0.3096	0.2924	0.0357	0.0655	0.1076	0.2414	0.1894
IQI #12 In-Hosp Mort CABG	0.2807	0.5502	0.6852	0.8235	0.7464	0.3746	0.5478	0.6804	0.8240	0.7239
IQI #13 In-Hosp Mort Craniotomy	0.0862	0.2853	0.4818	0.7074	0.6915	0.0240	0.1320	0.3011	0.6789	0.5847
IQI #14 In-Hosp Mort Hip Replacement	0.0589	0.1607	0.3120	0.5258	0.4767	0.2781	0.5722	0.7620	0.9136	0.8401
IQI #15 In-Hosp Mort AMI	0.0620	0.2412	0.5030	0.7374	0.7160	0.0330	0.1341	0.3754	0.6613	0.5958
IQI #16 In-Hosp Mort CHF	0.1182	0.3692	0.6474	0.8334	0.7550	0.0826	0.2286	0.4817	0.7190	0.6136
IQI #17 In-Hosp Mort Stroke	0.1102	0.3562	0.6458	0.8649	0.7800	0.0385	0.1272	0.3489	0.7090	0.5879
IQI #18 In-Hosp Mort GI Hemorrhage	0.0386	0.1616	0.3535	0.5761	0.4878	0.0176	0.0728	0.1907	0.3817	0.2972
IQI #19 In-Hosp Mort Hip Fracture	0.0968	0.2908	0.4758	0.6551	0.5619	0.0409	0.1048	0.1987	0.3575	0.2768
IQI #20 In-Hosp Mort Pneumonia	0.2128	0.5509	0.7832	0.8983	0.8222	0.1407	0.3046	0.5147	0.7073	0.5875
IQI #30 In-Hosp Mort PTCA	0.1038	0.3710	0.5563	0.7220	0.6599	0.1045	0.2391	0.3699	0.5793	0.4809
IQI #31 In-Hosp Mort Carotid Endarterectomy	0.0086	0.0315	0.0721	0.1732	0.1523	0.0083	0.0240	0.0567	0.1479	0.1081
IQI #32 In-Hosp Mort AMI w/o Transfers						0.0348	0.1453	0.3770	0.6282	0.5578

Note: Composite Workgroup Report results are based on the AHRQ QI SAS Software (Version 3) and the reference population is the 2001-2003 HCUP State Inpatient Databases (including all payers). The updated results are based on the AHRQ QI SAS Software (Version 4.1b) and the reference population is the 2007 HCUP State Inpatient Databases (including all payers).

Table I2. Reliability Weights and Discrimination in Current Version.

AHRQ QI	Version 4.1 (December, 2009)		Version 4.1b (June, 2010)		95% Interval	
	Signal Variance	Signal Standard Deviation	Signal Variance	Signal Standard Deviation	Better Than Average	Worse than Average
IQI #08 In-Hosp Mort Esophageal Resection	0.000753981836	0.027458729687	0.001518830119	0.038972171084	0.22%	0.78%
IQI #09 In-Hosp Mort Pancreatic Resection	0.000478894761	0.021883664250	0.000664672995	0.025781252782	0.00%	0.26%
IQI #11 In-Hosp Mort AAA Repair	0.000021708836	0.004659274192	0.000200235184	0.014150448191	0.06%	0.06%
IQI #12 In-Hosp Mort CABG	0.000168738778	0.012989949115	0.000324103313	0.018002869577	6.50%	17.72%
IQI #13 In-Hosp Mort Craniotomy	0.000157324111	0.012542890855	0.000408147424	0.020202658835	2.75%	4.38%
IQI #14 In-Hosp Mort Hip Replacement	0.000012527311	0.003539394157	0.000093399373	0.009664335104	-	5.75%
IQI #15 In-Hosp Mort AMI	0.000054274441	0.007367118908	0.000281382980	0.016774474060	2.65%	3.07%
IQI #16 In-Hosp Mort CHF	0.000023264330	0.004823311103	0.000141607137	0.011899879705	3.86%	5.87%
IQI #17 In-Hosp Mort Stroke	0.000204469768	0.014299292570	0.000459016064	0.021424660184	4.36%	4.54%
IQI #18 In-Hosp Mort GI Hemorrhage	0.000007165442	0.002676834324	0.000045396762	0.006737711926	0.18%	0.98%
IQI #19 In-Hosp Mort Hip Fracture	0.000023856644	0.004884326361	0.000088526892	0.009408873046	0.19%	0.68%
IQI #20 In-Hosp Mort Pneumonia	0.000043631051	0.006605380458	0.000193490601	0.013910089899	3.48%	7.93%
IQI #30 In-Hosp Mort PTCA	0.000002483160	0.001575804556	0.000015938894	0.003992354443	1.20%	3.66%
IQI #31 In-Hosp Mort Carotid Endarterectomy	0.000000259689	0.000509596900	0.000006004590	0.002450426493	0.00%	0.25%
IQI #32 In-Hosp Mort AMI w/o Transfers	0.000051990550	0.007210447282	0.000334636507	0.018293072651	2.48%	2.93%
Mortality for Selected Procedures (composite)					1.86%	4.47%
Mortality for Selected Conditions (composite)					7.67%	9.42%

Note: The 95% interval is based on the "smoothed rate" (S) and the standard deviation of the smoothed rate (X) as reported by the AHRQ QI SAS Software.

Table I3. Reliability Weights using Alternative Computation.

AHRQ QI	Version 4.1b (June, 2010)		Alternative Computation Based on Covariance	
	Signal Variance	Signal Standard Deviation	Signal Variance	Signal Standard Deviation
IQI #08 In-Hosp Mort Esophageal Resection	0.001518830119	0.038972171084	0.000891446000	0.029857092960
IQI #09 In-Hosp Mort Pancreatic Resection	0.000664672995	0.025781252782	0.000345341500	0.018583366218
IQI #11 In-Hosp Mort AAA Repair	0.000200235184	0.014150448191	0.000138784100	0.011780666365
IQI #12 In-Hosp Mort CABG	0.000324103313	0.018002869577	0.000189284000	0.013758052188
IQI #13 In-Hosp Mort Craniotomy	0.000408147424	0.020202658835	0.000346980200	0.018627404543
IQI #14 In-Hosp Mort Hip Replacement	0.000093399373	0.009664335104	0.000095534000	0.009774149579
IQI #15 In-Hosp Mort AMI	0.000281382980	0.016774474060	0.000252465200	0.015889153533
IQI #16 In-Hosp Mort CHF	0.000141607137	0.011899879705	0.000133510600	0.011554678706
IQI #17 In-Hosp Mort Stroke	0.000459016064	0.021424660184	0.000451634500	0.021251694050
IQI #18 In-Hosp Mort GI Hemorrhage	0.000045396762	0.006737711926	0.000045259300	0.006727503252
IQI #19 In-Hosp Mort Hip Fracture	0.000088526892	0.009408873046	0.000091048600	0.009541939006
IQI #20 In-Hosp Mort Pneumonia	0.000193490601	0.013910089899	0.000190241500	0.013792806096
IQI #30 In-Hosp Mort PTCA	0.000015938894	0.003992354443	0.000014040000	0.003746998799
IQI #31 In-Hosp Mort Carotid Endarterectomy	0.000006004590	0.002450426493	0.000009936400	0.003152205577
IQI #32 In-Hosp Mort AMI w/o Transfers	0.000334636507	0.018293072651	0.000294277100	0.017154506696

Patient Safety Indicators

Table S1. Reliability Weights Compared to Composite Workgroup Report

AHRQ QI	PSI Composite Workgroup Report				Weighted Average	Version 4.1b (June, 2010)				Weighted Average
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4	
PSI #02 Death in Low Mortality DRGs						0.0275	0.0994	0.2389	0.4588	0.3862
PSI #03 Pressure Ulcer	0.4062	0.7970	0.9253	0.9807	0.9584	0.3037	0.6573	0.8783	0.9697	0.9281
PSI #04 Death among Surgical Inpatients						0.0357	0.1474	0.3423	0.6749	0.5730
PSI #06 Iatrogenic Pneumothorax	0.0861	0.2641	0.5638	0.8101	0.7288	0.0303	0.0833	0.2823	0.5752	0.4710
PSI #07 Central Venous Catheter-related Bloodstream Infections	0.2536	0.5670	0.8215	0.9367	0.8872	0.1102	0.2347	0.5370	0.7995	0.6951
PSI #08 Postoperative Hip Fracture	0.0043	0.0155	0.0542	0.1714	0.1741	0.0012	0.0080	0.0354	0.1642	0.1333
PSI #09 Postoperative Hemorrhage or Hematoma	0.0265	0.1894	0.4826	0.7650	0.7202	0.0209	0.1183	0.3403	0.6745	0.5824
PSI #10 Postoperative Physiologic and Metabolic Derangements	0.0237	0.1015	0.3083	0.6554	0.6263	0.0295	0.1267	0.3427	0.7076	0.6112
PSI #11 Postoperative Respiratory Failure	0.1212	0.4432	0.7361	0.9040	0.8664	0.1248	0.3636	0.6494	0.8807	0.8063
PSI #12 Postoperative PE Or DVT	0.1776	0.6277	0.8797	0.9624	0.9381	0.1969	0.5796	0.8463	0.9577	0.9164
PSI #13 Postoperative Sepsis	0.0575	0.2168	0.4372	0.7320	0.7023	0.0303	0.0980	0.2854	0.6531	0.5567
PSI #14 Postoperative Wound Dehiscence	0.0248	0.1380	0.3114	0.5436	0.4904	0.0128	0.0601	0.1559	0.3726	0.2989
PSI #15 Accidental Puncture or Laceration	0.1905	0.5571	0.8557	0.9614	0.9099	0.0811	0.2517	0.6135	0.8645	0.7597

Note: Composite Workgroup Report results are based on the AHRQ QI SAS Software (Version 3) and the reference population is the 2001-2003 HCUP State Inpatient Databases (including all payers). The updated results are based on the AHRQ QI SAS Software (Version 4.1b) and the reference population is the 2007 HCUP State Inpatient Databases (including all payers).

Table S2. Reliability Weights and Discrimination in Current Version.

AHRQ QI	Version 4.1 (December, 2009)		Version 4.1b (June, 2010)		95% Interval	
	Signal Variance	Signal Standard Deviation	Signal Variance	Signal Standard Deviation	Better Than Average	Worse than Average
PSI #02 Death in Low Mortality DRGs	0.000000004422	0.000066498120	0.000000057586	0.000239970832	0.00%	2.00%
PSI #03 Pressure Ulcer	0.000125482434	0.011201894215	0.000167379454	0.012937521169	21.47%	27.92%
PSI #04 Death among Surgical Inpatients	0.000233738746	0.015288516802	0.000996672391	0.031570118641	1.89%	3.92%
PSI #06 Iatrogenic Pneumothorax	0.000000008947	0.000094588583	0.000000091725	0.000302861354	0.11%	3.18%
PSI #07 Central Venous Catheter-related Bloodstream Infections	0.000000105291	0.000324485747	0.000001195392	0.001093339837	2.63%	8.32%
PSI #08 Postoperative Hip Fracture	0.000000008873	0.000094196603	0.000000007696	0.000087726849	0.15%	0.12%
PSI #09 Postoperative Hemorrhage or Hematoma	0.000000171819	0.000414510555	0.000000998032	0.000999015515	1.29%	3.79%
PSI #10 Postoperative Physiologic and Metabolic Derangements	0.000000139072	0.000372923585	0.000000761383	0.000872572633	0.42%	4.50%
PSI #11 Postoperative Respiratory Failure	0.000004180891	0.002044722720	0.000028496408	0.005338202694	6.73%	10.17%
PSI #12 Postoperative PE Or DVT	0.000009224783	0.003037232787	0.000045285303	0.006729435563	14.01%	11.29%
PSI #13 Postoperative Sepsis	0.000007393919	0.002719176162	0.000032838685	0.005730504777	2.03%	3.92%
PSI #14 Postoperative Wound Dehiscence	0.000000150885	0.000388439184	0.000001288164	0.001134973127	0.05%	1.34%
PSI #15 Accidental Puncture or Laceration	0.000000483883	0.000695616992	0.000002838513	0.001684788711	6.49%	8.72%
Patient Safety for Selected Indicators (composite)					16.85%	19.35%

Note: The 95% interval is based on the "smoothed rate" (S) and the standard deviation of the smoothed rate (X) as reported by the AHRQ QI SAS Software.

Table S3. Reliability Weights using Alternative Computation.

AHRQ QI	Version 4.1b (June, 2010)		Alternative Computation Based on Covariance	
	Signal Variance	Signal Standard Deviation	Signal Variance	Signal Standard Deviation
PSI #02 Death in Low Mortality DRGs	0.000000057586	0.000239970832	0.000000057338	0.000239454553
PSI #03 Pressure Ulcer	0.000167379454	0.012937521169	0.000157720400	0.012558678274
PSI #04 Death among Surgical Inpatients	0.000996672391	0.031570118641	0.001021777300	0.031965251446
PSI #06 Iatrogenic Pneumothorax	0.000000091725	0.000302861354	0.000000090809	0.000301345106
PSI #07 Central Venous Catheter-related Bloodstream Infections	0.000001195392	0.001093339837	0.000001195368	0.001093328953
PSI #08 Postoperative Hip Fracture	0.000000007696	0.000087726849	0.000000008013	0.000089513122
PSI #09 Postoperative Hemorrhage or Hematoma	0.000000998032	0.000999015515	0.000000960938	0.000980274405
PSI #10 Postoperative Physiologic and Metabolic Derangements	0.000000761383	0.000872572633	0.000000762137	0.000873004376
PSI #11 Postoperative Respiratory Failure	0.000028496408	0.005338202694	0.000028484400	0.005337077852
PSI #12 Postoperative PE Or DVT	0.000045285303	0.006729435563	0.000042083600	0.006487187372
PSI #13 Postoperative Sepsis	0.000032838685	0.005730504777	0.000035225200	0.005935082139
PSI #14 Postoperative Wound Dehiscence	0.000001288164	0.001134973127	0.000001391088	0.001179443979
PSI #15 Accidental Puncture or Laceration	0.000002838513	0.001684788711	0.000002818475	0.001678831528

Figure I.1 Total Variance, Signal Variance and Noise Variance by Denominator Size.