

Hybrid Hospital-Wide Readmission (HWR) Measure Submission to PQM: Figures and Tables

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Figure 1. HWR Flow Diagram of Inclusion and Exclusion Criteria and Specialty Cohort Assignment for the Index Admission

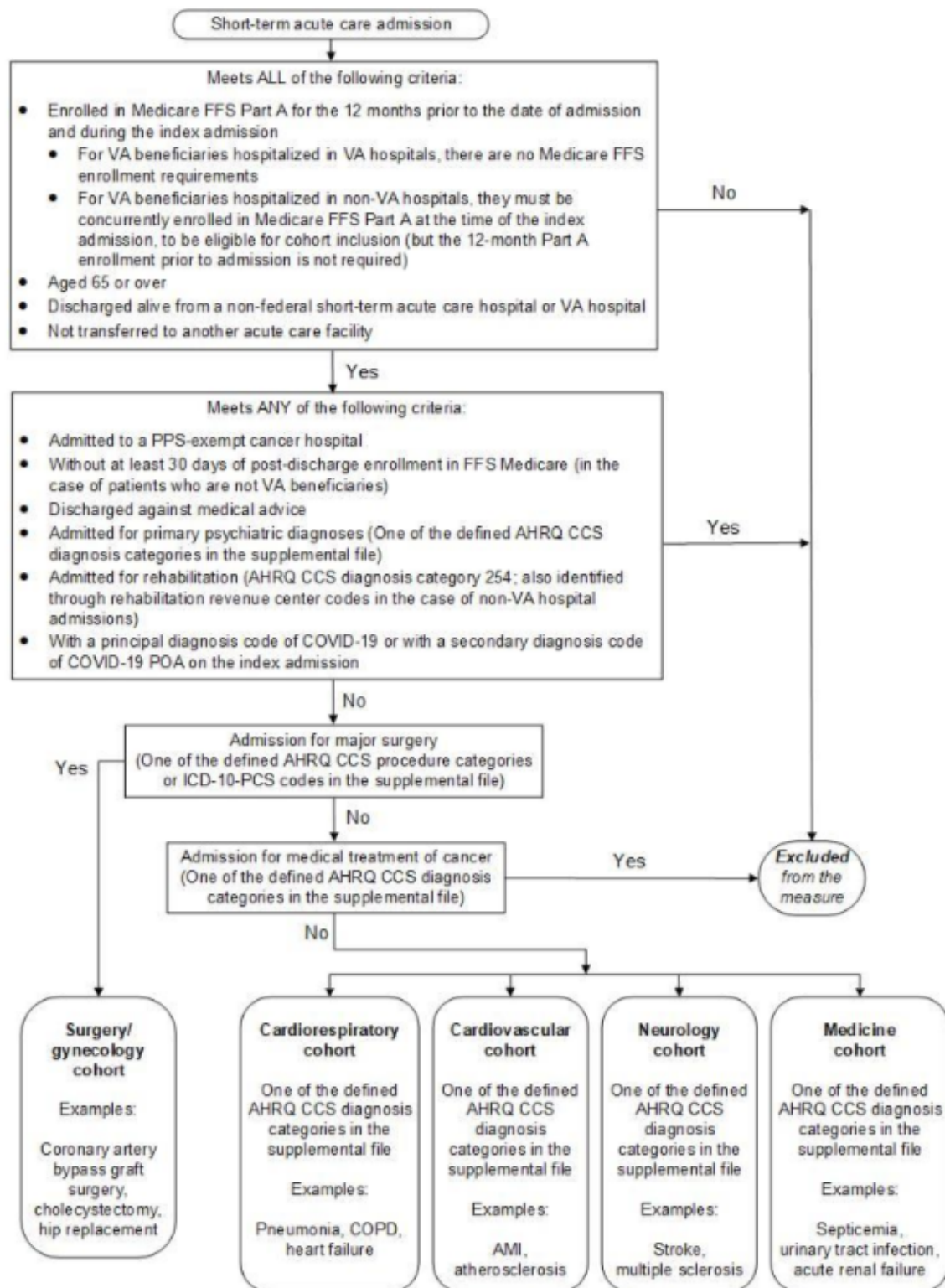


Figure 2. Hybrid HWR Logic Model

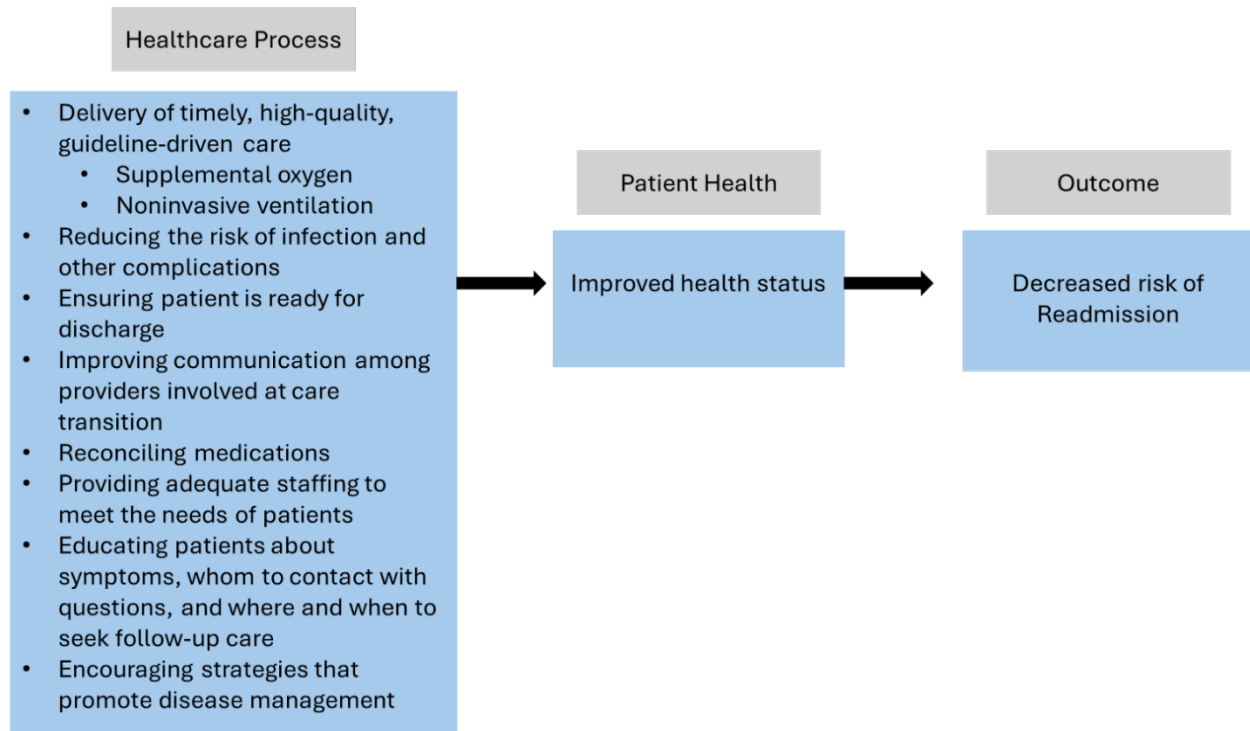


Table 1. RSRR by Decile—Claims-Only HWR (Medicare FFS + MA) dataset (Discharges July 1, 2018, through June 30, 2019)

	Overall	Min	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10	Max
Mean Score	15.48	10.37	13.53	14.40	14.78	15.05	15.29	15.49	15.74	16.08	16.57	17.92	47.22
Entities	4,782	1	478	478	478	479	478	478	479	478	478	478	1
Total Persons	11,029,470	3,802	1,321,954	1,160,299	899,771	701,058	735,186	681,808	969,925	1,256,604	1,445,531	1,857,334	1,416

Table 2. Claims-Only HWR (Medicare FFS + MA) dataset Measure Score (Risk-Standardized Readmission Rate or RSRR) Distribution for Discharges July 1, 2018, through June 30, 2019

Description	Value
Number of hospitals	4,782
Mean and Standard Deviation	15.48% (1.28%)
0% Min	10.37%
10%	14.12%
25% Q1	14.79%
50% Median	15.40%
75% Q3	16.06%
90%	16.92%
95%	17.56%
99%	19.03%
100% Max	47.22%

Table 3. Hybrid HWR 2024 Voluntary Reporting Dataset Measure Score (Risk-Standardized Readmission Rate or RSRR) Distribution for Discharges July 1, 2022 through June 30, 2023

Description	Value
Number of hospitals	1,162
Mean and Standard Deviation	14.29% (0.59%)
0% Min	10.21%
10%	13.63%
25% Q1	13.97%
50% Median	14.26%
75% Q3	14.58%
90%	15.01%
95%	15.25%
99%	15.93%
100% Max	16.90%

Figure 3. Distribution (Histogram) Of Hospital-Wide RSRRs (Claims-Only HWR [Medicare FFS + MA] dataset) for Discharges July 1, 2018, through June 30, 2019

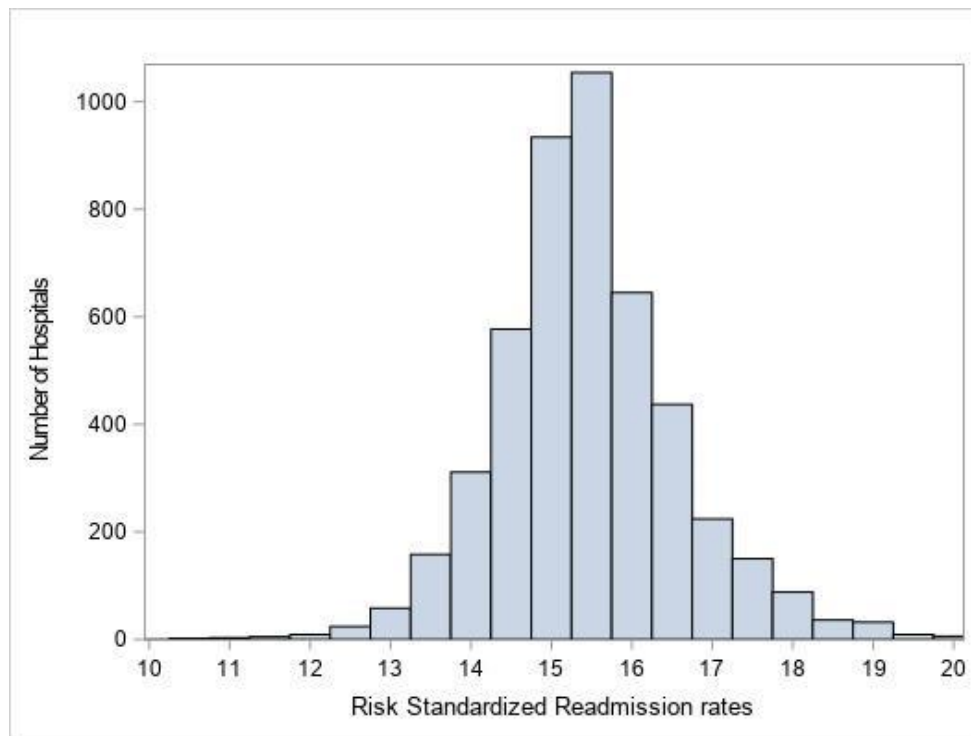


Figure 4. Distribution (Histogram) of Hospital-Wide RSRRs (Hybrid HWR 2024 Voluntary Reporting Dataset) for Discharges July 1, 2022-June 30, 2023

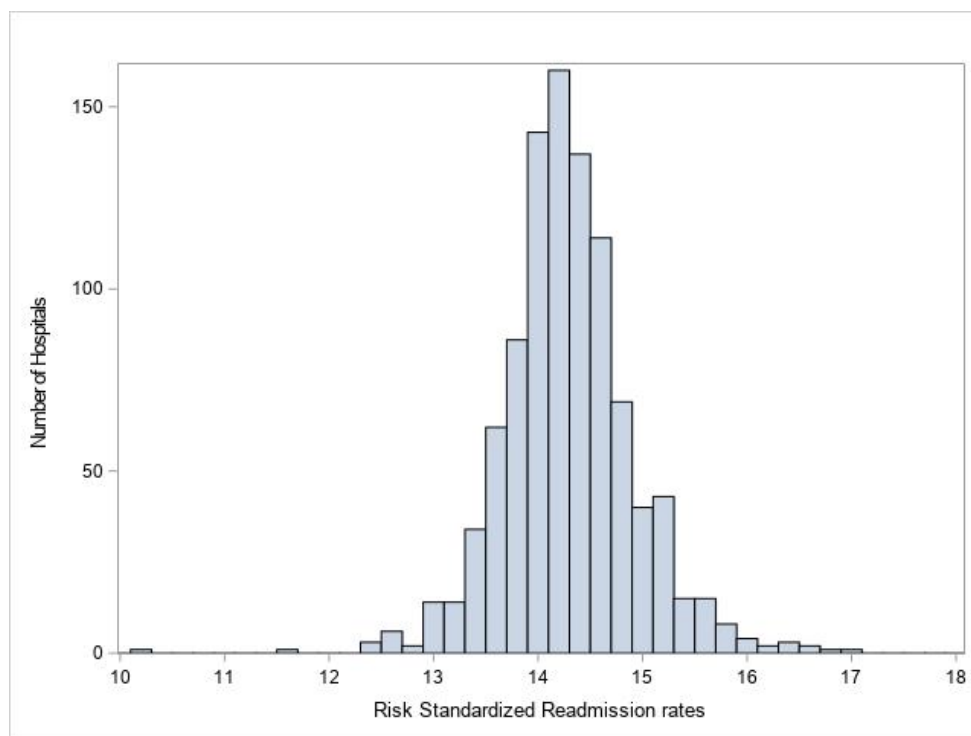


Table 4. Dataset Descriptions

Dataset	Applicable Section in the Testing Attachment	Description of Dataset
<p>Claims-based All Cause Unplanned Hospital-Wide Readmission (HWR) Dataset (Medicare FFS and Medicare Advantage)</p> <p>(Dataset 2, 2a – Development; 2b - Validation)</p> <p>For testing, we used a one-year dataset containing combined FFS + MA inpatient claims for patients discharged between July 1, 2018, through June 30, 2019, from acute care hospitals. This dataset does not include CCDE for case-mix risk adjustment, but it is utilized to represent the Medicare Advantage population, for which the measure cohort was recently expanded for 2026 Reporting through rulemaking.</p>	<ul style="list-style-type: none"> • Risk Adjustment/Stratification • Statistical Risk Model Calibration Statistics • Reliability (Measure Score) • Equity 	<p>Dates of Data: July 1, 2018, through June 30, 2019</p> <p>Number of admissions = 11,029,470</p> <p>Number of hospitals = 4,782</p> <p>Patient Descriptive Characteristics: mean age = 78 years; standard deviation = 8 years</p> <p>The number of index admissions is listed below by specialty cohort.</p> <p>Cardiorespiratory Overall: 1,306,739 Development sample: 653,370 admissions Validation sample 653,369 admissions</p> <p>Cardiovascular Overall: 1,158,878 Development sample: 579,439 admissions Validation sample: 579,439 admissions</p> <p>Medicine Overall: 5,306,659 Development sample: 2,653,329 admissions Validation sample: 2,653,330 admissions</p> <p>Neurology Overall: 645,101 Development sample: 322,551 admissions Validation sample: 322,550 admissions</p> <p>Surgical/Gynecological Overall: 2,612,093 Development sample: 1,306,046 admissions Validation sample: 1,306,047 admissions</p>

<p>Hybrid Hospital-Wide Readmission 2024 Voluntary Reporting Dataset (Dataset 3, 3a – Development; 3b – Validation)</p> <p>For testing, we used a one-year dataset containing combined FFS inpatient claims for patients discharged between July 1, 2022, through June 30, 2023, from acute care hospitals, matched with CCDE for claims-mix risk-adjustment. This dataset does not include Medicare Advantage patients but is used to represent a sample with CCDE reported by hospitals, for which the measure is specified.</p>	<ul style="list-style-type: none"> • Risk Adjustment/Stratification • Statistical Risk Model • Calibration Statistics • Reliability (Measure Score) • Missing Data 	<p>Dates of Data: July 1, 2022-June 30, 2023</p> <p>Total number of hospitals: 1,162</p> <p>Total number of admissions: 1,538,437</p> <p>Patient Descriptive Characteristics: Mean age= 78 Standard deviation= 8</p> <p>Cardiorespiratory Overall:146,881 admissions Development sample: 73,441 admissions Validation sample:73,440 admissions</p> <p>Cardiovascular Overall: 159,169 admissions Development sample: 79,584 admissions Validation sample: 79,585 admissions</p> <p>Medicine Overall: 747,613 admissions Development sample: 373,807 admissions Validation sample: 373,806 admissions</p> <p>Neurology Overall: 105,452 Development sample: 52,726 admissions Validation: sample 52,726 admissions</p> <p>Surgical/Gynecological Overall: 379,322 admissions Development sample: 189,661 admissions Validation sample: 189,661 admissions</p>
<p>Development and Validation Datasets (Kaiser Permanente merged clinical and EHR dataset) (Dataset 1, 1a – Development; 1b - Validation)</p>	<ul style="list-style-type: none"> • Reliability (Data Element) • Validity (Data Element) • Feasibility 	<p>Dates of Data: Development/Validation sample= January 1, 2010 –December 31, 2012 2012 sample= January 1, 2012—December 31, 2012</p> <p>Number of admissions = 381,980</p>

<p>This data source includes all-payer inpatient claims for all adults merged with clinical data elements derived from patients' EHRs, using three years of data, in which the third year (2012 sample) was used to test stability.</p>		<p>Number of hospitals = 21</p> <p>Patient Descriptive Characteristics: mean age = 58 years; standard deviation = 21 years %female = 62.6</p> <p>The number of index admissions is listed below by specialty cohort.</p> <p>Surgical/Gynecological Development sample: 23,201 admissions Validation sample: 23,490 admissions 2012 sample: 25,471 admissions</p> <p>Cardiorespiratory Development sample: 9,261 admissions Validation sample: 9,364 admissions 2012 sample: 9,070 admissions</p> <p>Cardiovascular Development sample: 8,108 admissions Validation sample: 8,037 admissions 2012 sample: 8,338 admissions</p> <p>Neurology Development sample: 4,400 admissions Validation sample: 4,348 admissions 2012 sample: 4,487 admissions</p> <p>Medicine Development sample: 34,619 admissions Validation sample: 34,574 admissions 2012 sample: 35,747 admissions</p>
<p>Electronically extracted clinical data from three hospitals that used Cerner as their clinical EHR (Dataset 4)</p>	<ul style="list-style-type: none"> Validity (Data Element) 	<p>Dates of Data: January 1, 2010 through December 31, 2012</p> <p>3 hospitals with 25,829; 56,812; and 29,586 admissions, respectively.</p> <p>This was inclusive of both Medicare FFS and Medicare Advantage, as data was all-payer.</p>
<p>Data element validity testing dataset (Dataset 5)</p>	<ul style="list-style-type: none"> Validity (Data Element) 	<p>Dates of Data: January 1, 2010 through December 31, 2012</p>

		Data were electronically extracted from EHR for 391 admissions, from an individual hospital using GE Centricity as their EHR vendor. This was inclusive of both Medicare FFS and Medicare Advantage, as data was all-payer.
ADI index	<ul style="list-style-type: none"> • Risk Adjustment/ Stratification 	<p>Dates of Data: July 2023</p> <p>We used ADI data to derive areas of socioeconomic disadvantage based on zip code, for use in studying the association between the Hybrid HWR measure and social risk factors.</p>

Table 6. Hypothesized Strength and Direction of Association of Measure Scores with the Hospital-Wide Readmission Measure Score

Candidate Measure for Validity testing	Hypothesized Strength of Association	Hypothesized Direction of Association
Star Rating Standardized Readmission Group Score (without the HWR measure)	Moderate/Strong	Negative
Star Rating Standardized Summary Score (without the HWR measure)	Weak/Moderate	Negative
HCAHPS: Care Transition Performance Rate	Weak/Moderate	Negative
HCAHPS: Discharge information linear mean score	Weak/Moderate	Negative

Table 7. Percent Agreement and Confidence Internals for CCDE (Dataset 4-Cerner and 5-GE Centricity) for Discharges July 1, 2018, through June 30, 2019

Data Element/ CCDE	% Agreement Between Datasets (Number Matching/ Total Records With Abstracted and Electronic Data)	95% Confidence Internal for Agreement	% Present in Electronic Extraction, Missing in Manual Abstraction (N)	% Present in Manual Abstraction, Missing in Electronic Extraction (N)	% Missing in Both Electronic Extraction and Manual Abstraction (N)
Dataset 4 (n=368)					
Heart rate (BPM)	95.55 (322/337)	92.76 - 97.49	0 (0.00)	8.42 (31)	0 (0.00)
Systolic Blood Pressure (mmHG)	94.67 (320/338)	91.71 - 96.81	0 (0.00)	8.15 (30)	0 (0.00)
Respiratory Rate (BPM)	94.89 (316/333)	91.95 - 97.00	0 (0.00)	9.51 (35)	0 (0.00)
Temperature (C)	95.41 (312/327)	92.55 - 97.41	0 (0.00)	10.87 (40)	0.27 (1)
Oxygen Saturation (%)	94.68 (285/301)	91.51 - 96.93	0.27 (1)	14.40 (53)	3.53 (13)
Weight (Kg)*	14.66 (51/348)	11.11 - 18.81	1.09 (4)	3.53 (13)	0.82 (3)
Hematocrit (%)	96.19 (328/341)	93.57 - 97.95	0.82 (3)	3.80 (14)	2.72 (10)
Platelet (x10(9)/L)	96.88 (310/320)	94.33 - 98.49	0.82 (3)	4.62 (17)	7.61 (28)
WBC Count (x10(9)/L)	96.56 (309/320)	93.93 - 98.27	0.82 (3)	4.62 (17)	7.61 (28)
Potassium (meq/L)	97.22 (280/288)	94.60 - 98.79	0 (0.00)	5.16 (19)	16.58 (61)
Sodium (meq/L)	97.21 (279/287)	94.58 - 98.79	0 (0.00)	5.43 (20)	16.58 (61)
Bicarbonate (meq/L)	14.81 (8/54)	6.62 - 27.12	0.27 (1)	68.21 (251)	16.85 (62)

Glucose (mg/dL)	96.14 (274/285)	93.20 - 98.06	0 (0.00)	5.43 (20)	17.12 (63)
Dataset 5 (n=391)					
Heart rate (BPM)	57.45 (135/235)	50.85 - 63.85	0 (0.00)	39.39 (154)	0.51 (2)
Systolic Blood Pressure (mmHG)	60.26 (138/235)	53.61 - 66.65	0 (0.00)	40.92 (160)	0.51 (2)
Respiratory Rate (BPM)	70.14 (155/221)	63.63 - 76.09	0 (0.00)	42.71 (167)	0.77 (3)
Temperature (C)	79.09 (174/220)	73.11 - 84.27	0 (0.00)	42.46 (166)	1.28 (5)
Oxygen Saturation (%)	56.65 (115/203)	49.53 - 63.57	0.26 (1)	46.80 (183)	1.02 (4)
Weight (Kg)	84.41 (157/186)	78.38 - 89.30	0.26 (1)	48.34 (189)	3.84 (15)
Hematocrit (%)	91.67 (88/96)	84.24 - 96.33	0.26 (1)	58.31 (228)	16.88 (66)
Platelet (x10(9)/L)	94.68 (89/94)	88.02 - 98.25	0.26 (1)	59.08 (231)	16.62 (65)
WBC Count (x10(9)/L)	94.62 (88/93)	87.90 - 98.23	0.26 (1)	59.34 (232)	16.62 (65)
Potassium (meq/L)	86.75 (72/83)	77.52 - 93.19	0 (0.00)	62.66 (245)	16.11 (63)
Sodium (meq/L)	91.46 (75/82)	83.20 - 96.50	0 (0.00)	61.64 (241)	17.39 (68)
Bicarbonate (meq/L)	29.41 (5/17)	10.31 - 55.96	0.26 (1)	77.49 (303)	17.90 (70)
Glucose (mg/dL)	95.12 (78/82)	87.98 - 98.66	0 (0.00)	63.17 (247)	15.86 (62)

*Capture for weight is within the first 24 hours of admission because it is not likely to change substantially during that timeframe.

Table 8. Inclusion of CCDE variables in each specialty cohort

CCDE	Surgery/ Gynecology	Cardio- respiratory	Cardio- vascular	Neurology	Medicine
Bicarbonate	No	Yes	Yes	No	Yes
Creatinine	No	Yes	Yes	Yes	Yes
Glucose	No	Yes	No	No	Yes
Hematocrit	No	Yes	Yes	Yes	Yes
Potassium	No	No	Yes	No	Yes
Sodium	No	Yes	Yes	Yes	Yes
White Blood Cell Count	No	Yes	Yes	Yes	Yes
Oxygen Saturation	No	Yes	Yes	Yes	No
Heart Rate	Yes	Yes	Yes	Yes	Yes
Respiratory Rate	Yes	No	Yes	Yes	Yes
Systolic Blood Pressure	Yes	Yes	Yes	Yes	Yes
Temperature	Yes	Yes	No	Yes	Yes
Weight	Yes	No	No	No	No

Table 9. CCDE Missingness among Specialty Cohort using Hybrid HWR 2024 Voluntary Reporting dataset for discharges July 1, 2022-June 30, 2023

Description	Cardio- respiratory N (%)	Cardiovascular N (%)	Medicine N (%)	Neurology N (%)	Surgical/ Gynecological N (%)
Heart Rate	2,993 (2.04)	4,792 (3.01)	17,135 (2.29)	2,245 (2.13)	12,780 (3.37)
Systolic Blood Pressure	2,135 (1.45)	3,496 (2.20)	10,130 (1.35)	1,342 (1.27)	10,009 (2.64)
Respiratory Rate	--	4,799 (3.02)	12,655 (1.69)	1,686 (1.60)	13,830 (3.65)
Temperature	4,468 (3.04)	--	19,292 (2.58)	3,950 (3.75)	14,278 (3.76)
Oxygen Saturation	5,024 (3.42)	7,232 (4.54)	--	3,492 (3.31)	--
Weight	--	--	--	--	32,504 (8.57)
Hematocrit	4,010 (2.73)	10,826 (6.80)	24,260 (3.24)	4,785 (4.54)	--
White Blood Cell Count	30,258 (20.60)	38,183 (23.99)	152,504 (20.40)	22,862 (21.68)	--
Potassium	--	8,514 (5.35)	23,722 (3.17)	4,311 (4.09)	--
Sodium	4,990 (3.40)	8,713 (5.47)	25,949 (3.47)	4,539 (4.30)	--
Bicarbonate	10,696 (7.28)	16,288 (10.23)	58,298 (7.80)	--	--
Creatinine	3,335 (2.27)	7,254 (4.56)	17,953 (2.40)	3,332 (3.16)	--
Glucose	2,950 (2.01)	--	15,325 (2.05)	--	--

--CCDE not used in cohort calculation

Table 10. Pearson Correlation of Related Measure Scores with the Hospital-Wide Readmission Measure Score using Claims-Based HWR (Medicare FFS and MA) dataset for Discharges July 1, 2018, through June 30, 2019

Candidate Measure for Validity testing	Number of Hospitals	Pearson Correlation Coefficient	p-value
Star Rating Standardized Readmission Group Score (without the FFS-only claims-based HWR measure)	4,398	-0.52016	<.0001
Star Rating Standardized Summary Score (without the FFS-only claims-based HWR measure)	4517	-0.39802	<.0001
HCAHPS: Care Transition Performance Rate	3,437	-0.32447	<.0001
HCAHPS: Discharge information linear mean score	3,437	-0.32382	<.0001

Figure 5- Box-whisker plots of the HWR measure RSRRs within each quartile of Star-Rating readmission Group Score for Discharges July 1, 2018, through June 30, 2019

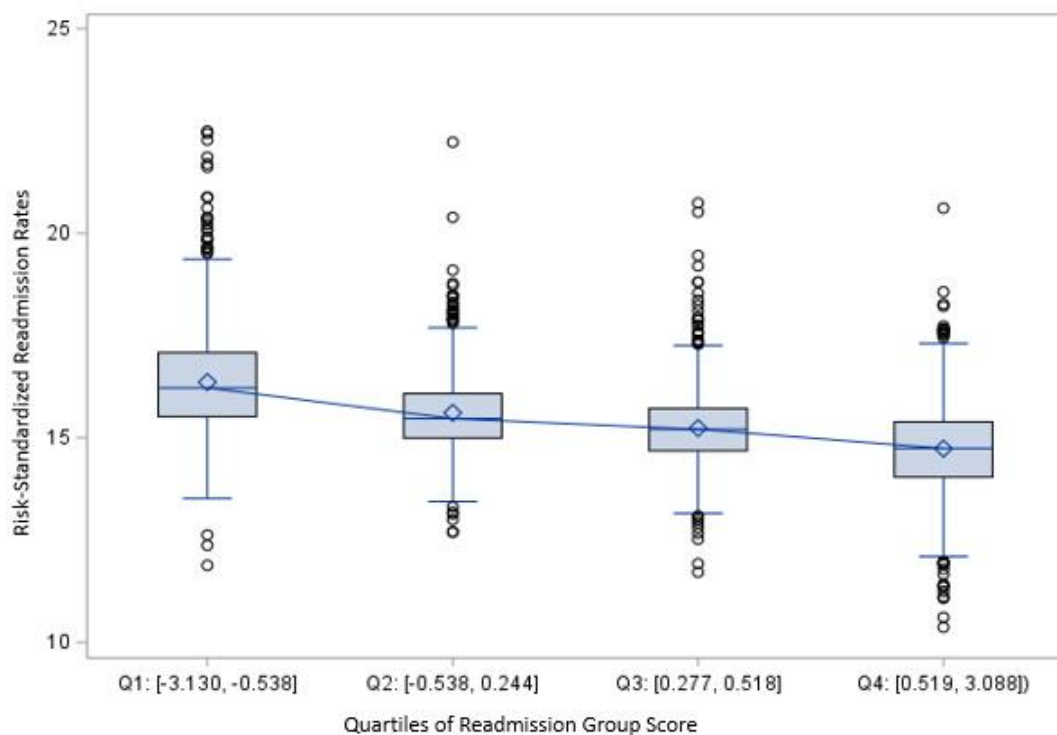


Figure 6- Box-whisker plots of the HWR readmission measure RSRRs within each quartile of Star-Rating Summary Scores for Discharges July 1, 2018, through June 30, 2019

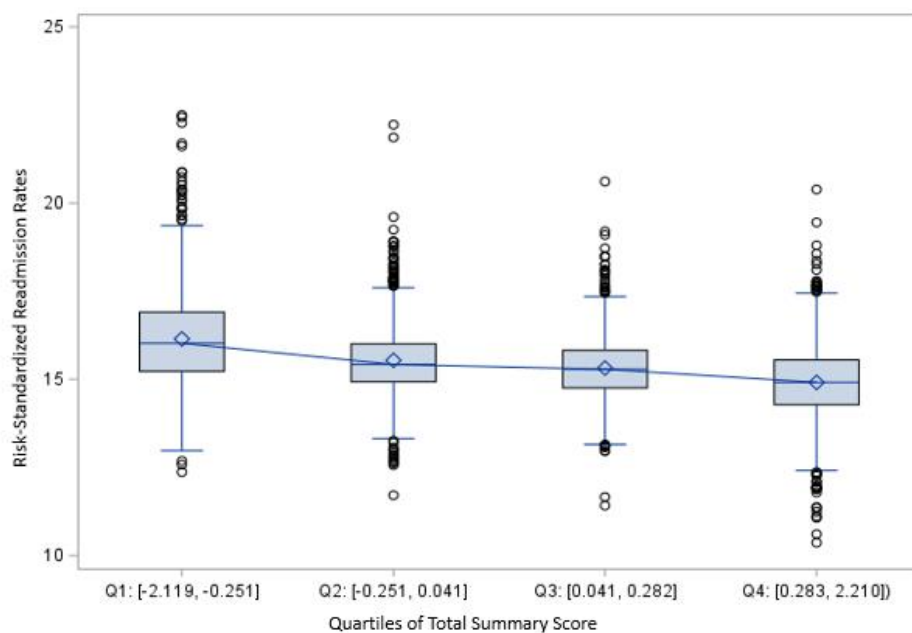


Figure 7 - Box-whisker plots of the HWR readmission measure RSRRs within each quartile of the HCAHPS Discharge Linear Mean Score for Discharges July 1, 2018, through June 30, 2019

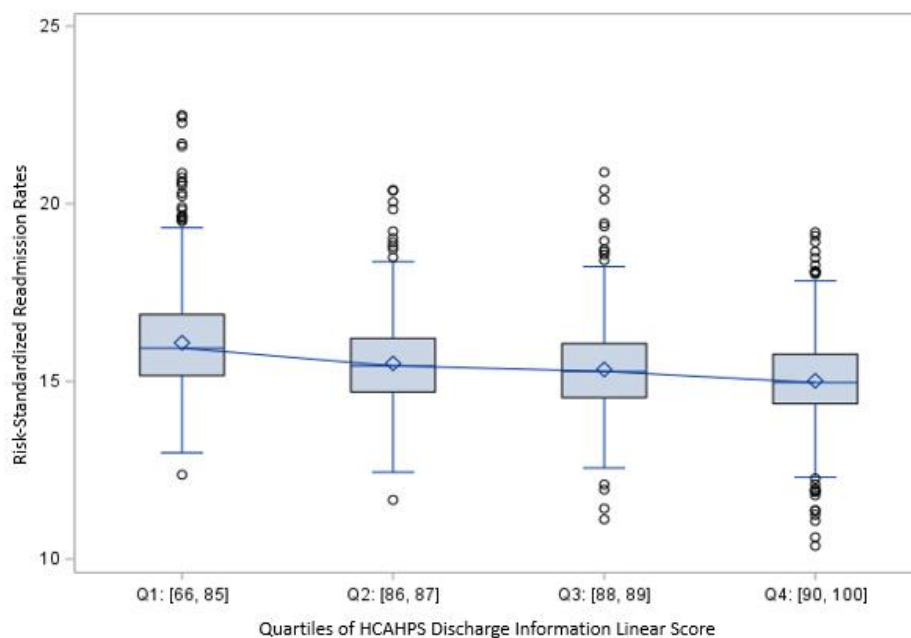


Figure 8 - Box-whisker plots of the HWR readmission measure RSRRs within each quartile of the HCAHPS Care Transition Performance Rate for Discharges July 1, 2018, through June 30, 2019

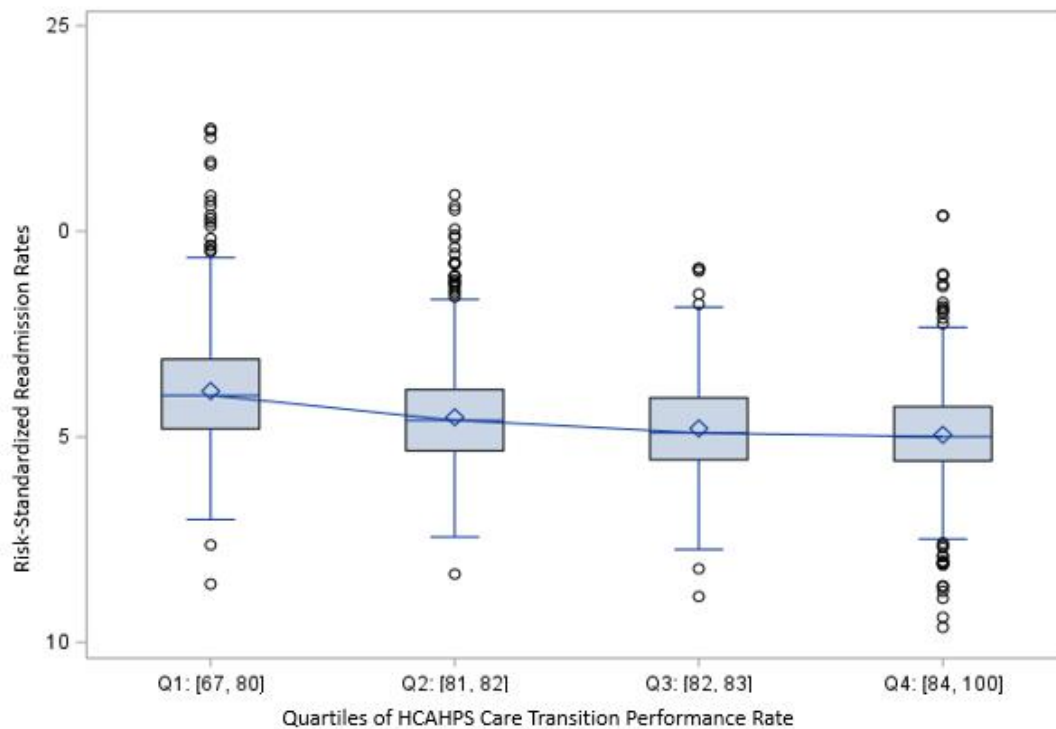


Table 11. Risk Adjustment Performance by Specialty Cohort (C-statistic)

Specialty Cohort	HWR	HWR + CCDE	CCDE+Principal Diagnosis	CCDE Only
Surgery/Gynecology	0.800	0.802	0.770	0.617
Cardiorespiratory	0.653	0.668	0.645	0.611
Cardiovascular	0.713	0.731	0.692	0.686
Neurology	0.670	0.708	0.674	0.672
Medicine	0.646	0.651	0.611	0.585

Table 12: C-statistic and discrimination (Claims-Only HWR [Medicare FFS and MA] Dataset) for Discharges July 1, 2018, through June 30, 2019

Specialty Cohort	Predictive Ability		C-statistic
	Lowest Decile	Highest Decile	
Cardiovascular	8.0%	25.4%	0.622
Cardiorespiratory	10.6%	28.6%	0.600
Medicine	9.6%	29.3%	0.613
Neurology	7.8%	22.3%	0.604
Surgical/Gynecological	2.3%	23.9%	0.695

Table 13. C-statistic and discrimination (2024 HHWR Voluntary Reporting Testing Dataset) for Discharges July 1, 2022, through June 30, 2023

Specialty Cohort	Predictive Ability		C-statistic
	Lowest Decile	Highest Decile	
Cardiovascular	3.7%	26.4%	0.680
Cardiorespiratory	6.2%	31.9%	0.656
Medicine	6.7%	30.9%	0.648
Neurology	5.0%	23.9%	0.642
Surgical/Gynecological	3.8%	24.4%	0.671

Table 14. Calibration in the Development and Validation Sample—Claims-Only HWR (Medicare FFS and MA (dataset for Discharges July 1, 2018, through June 30, 2019)

Specialty Cohort	Development Sample Dataset 2a	Validation Sample Dataset 2b
Surgical/Gynecological	(0.000, 1.000)	(0.013, 1.007)
Cardiorespiratory	(0.000, 1.000)	(-0.006, 0.995)
Cardiovascular	(0.000, 1.000)	(0.016, 1.009)
Neurology	(0.000, 1.000)	(-0.045,0.977)
Medicine	(0.000, 1.000)	(-0.009,0.994)

Table 15. Calibration in the Development and Validation Sample—Hybrid HWR 2024 Voluntary Reporting Dataset (discharges July 1, 2022-June 30, 2023)

Specialty Cohort	Development Sample Dataset 2a	Validation Sample Dataset 2b
Surgical/Gynecological	(0.000, 1.000)	(-0.072, 0.962)
Cardiorespiratory	(0.000, 1.000)	(-0.013, 0.990)
Cardiovascular	(0.000, 1.000)	(-0.076, 0.959)
Neurology	(0.000, 1.000)	(0.044, 1.021)
Medicine	(0.000, 1.000)	(-0.034,0.977)

Figure 9. Risk Decile Plot for all five hybrid HWR cohorts (Claims-Only HWR [Medicare FFS and MA] Dataset [for Discharges July 1, 2018, through June 30, 2019])

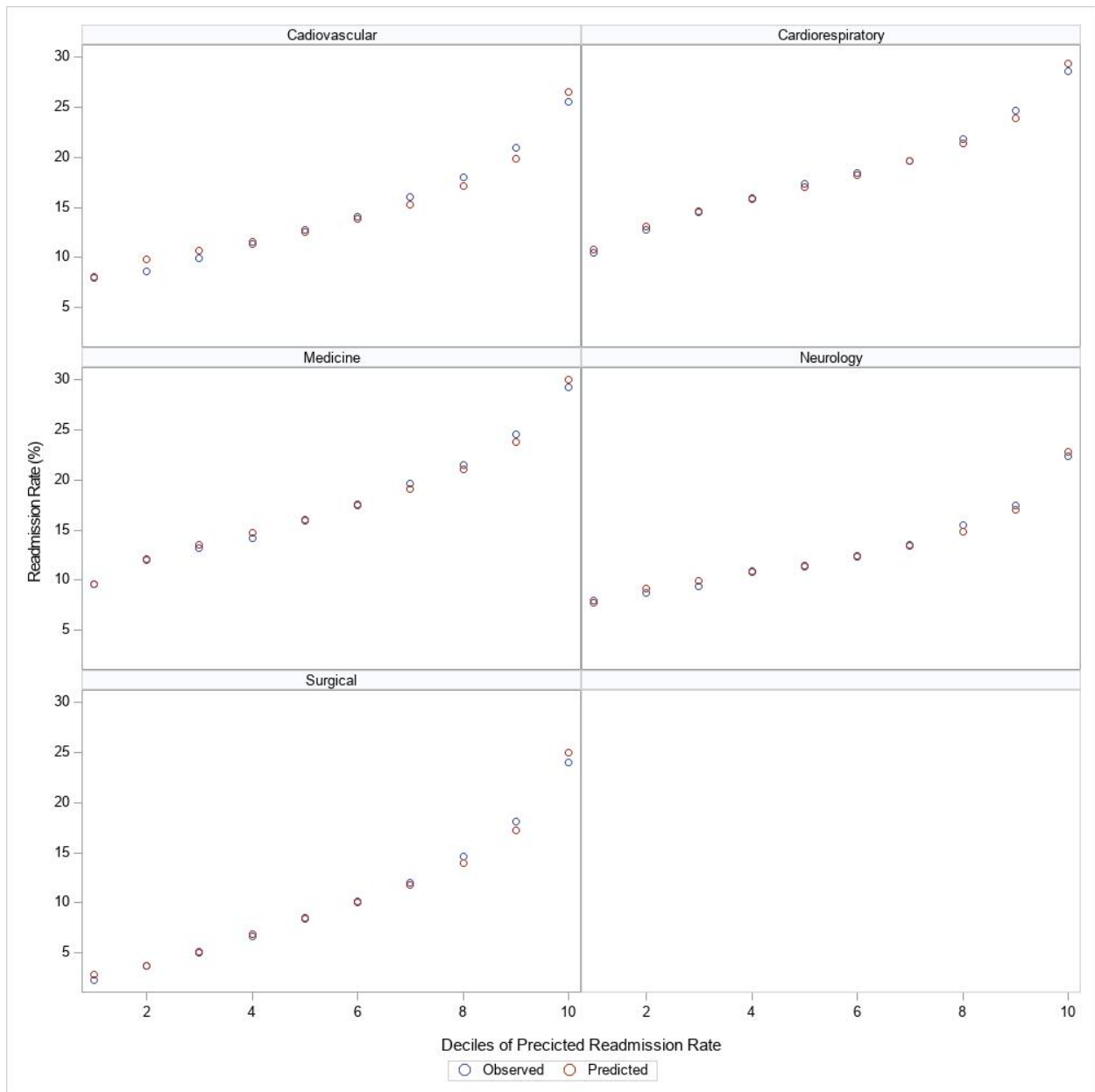


Figure 10. Risk Decile Plot for all five hybrid HWR cohorts (Hybrid HWR 2024 Voluntary Reporting Dataset [discharges July 1, 2022-June 30, 2023])

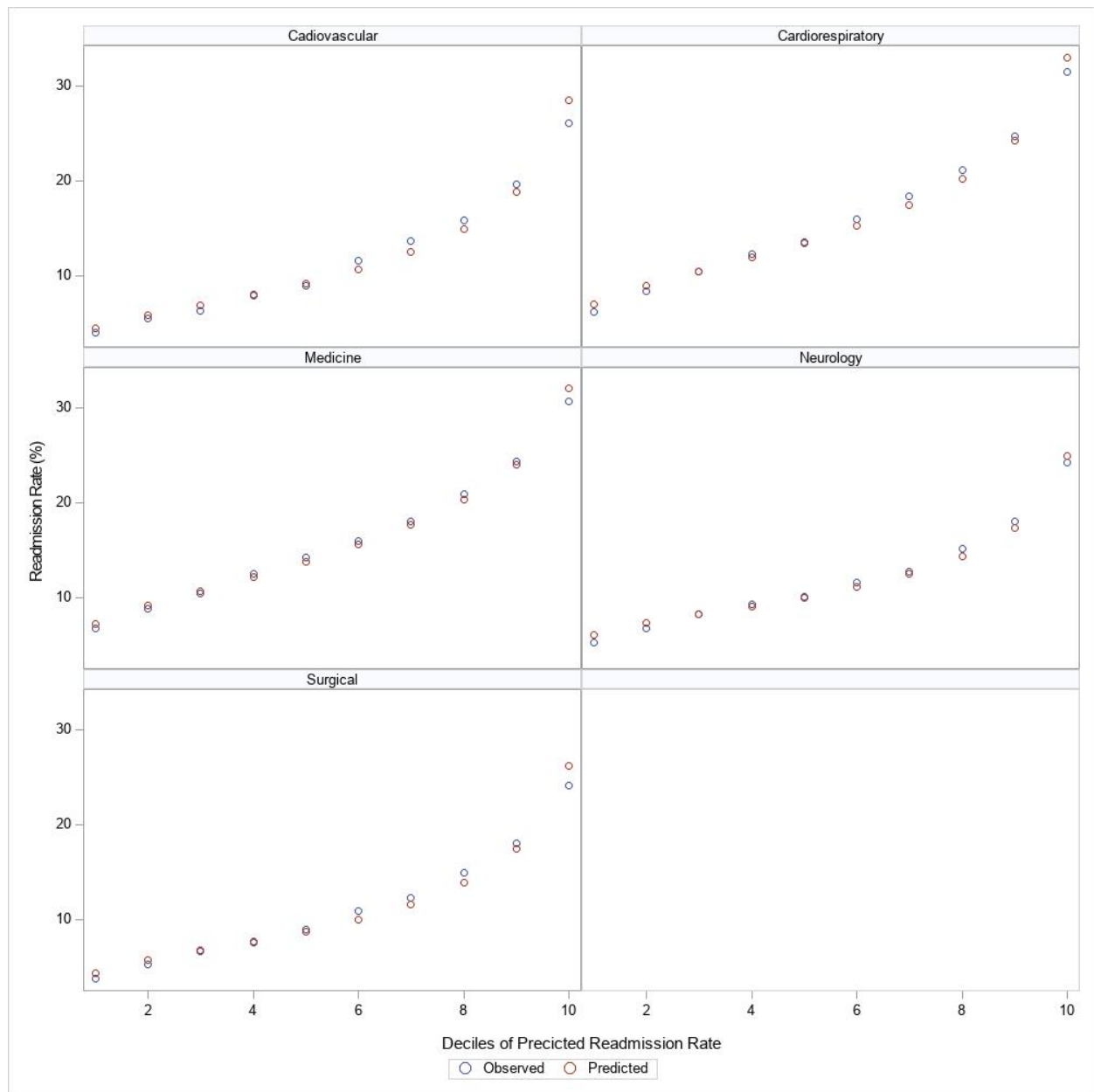


Table 16. Prevalence of social risk factors in the HWR cohort; Claims Only HWR (Medicare FFS and MA) dataset

Social Risk Factors	Claims Only HWR (Medicare FFS and MA) Prevalence [Median % (IQR)] (HN=4,782)
Dual-eligible (DE)	15.8% (10.8%-23.3%)
High Area Deprivation Index (ADI) (>85)	12.4% (2.4%-30.8%)

Table 17. Observed readmission rates in patients with and without social risk (Claims Only HWR (Medicare FFS and MA)

Social Risk Factors	Claims Only HWR (Medicare FFS and MA) [Observed Rate]
Dual-eligible (DE)	19.6%
Non-DE	14.7%
High Area Deprivation Index (ADI) (>85)	17.2%
Low ADI (<85)	15.2%

Table 19. Comparison of measure scores calculated with and without social risk factors (Claims-Only HWR (Medicare FFS and MA)

Metric	Difference in measure scores (RSRR)		Measure Score Correlation
<u>Social Risk factor</u>	Median	IQR	--
High ADI	0.0305	(0.012-0.058)	0.999
Dual-Eligibility	0.055	(0.023-0.108)	0.995

Figure 11: High ADI Claims-Only HWR (Medicare FFS and MA) dataset for Discharges July 1, 2018, through June 30, 2019

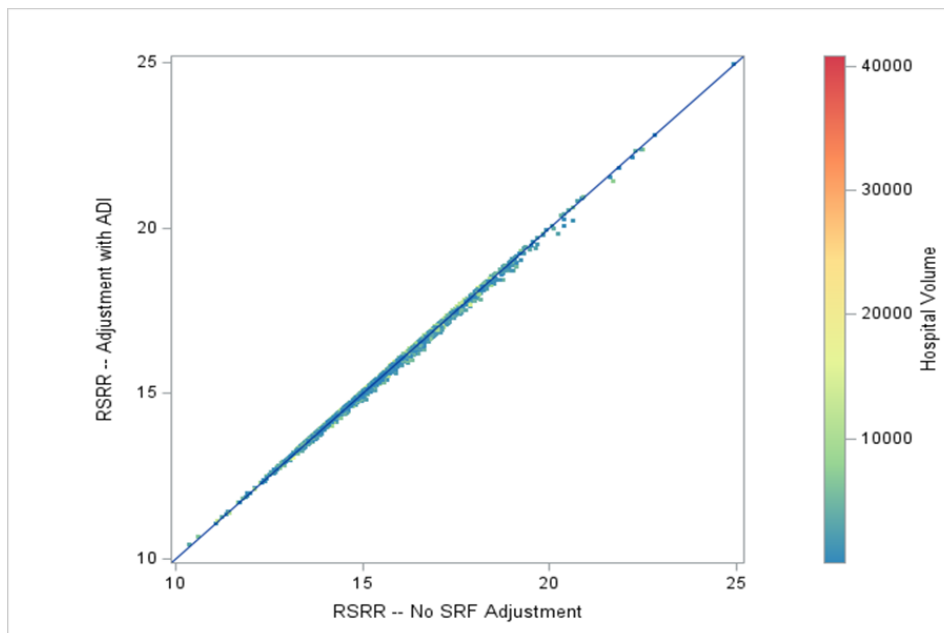


Figure 12: Dual-Eligibility among Claims-Only HWR (Medicare FFS and MA) dataset for Discharges July 1, 2018, through June 30, 2019

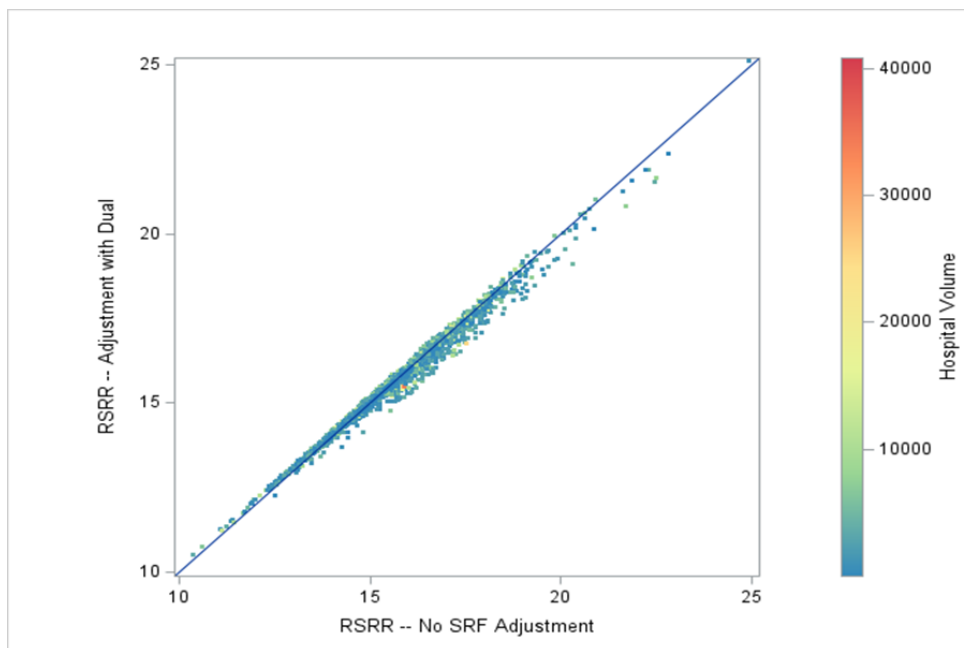


Figure 13. Patient-Level Observed Readmission Rates for HWR and Specialty Cohorts (2018 and 2024 Reporting)

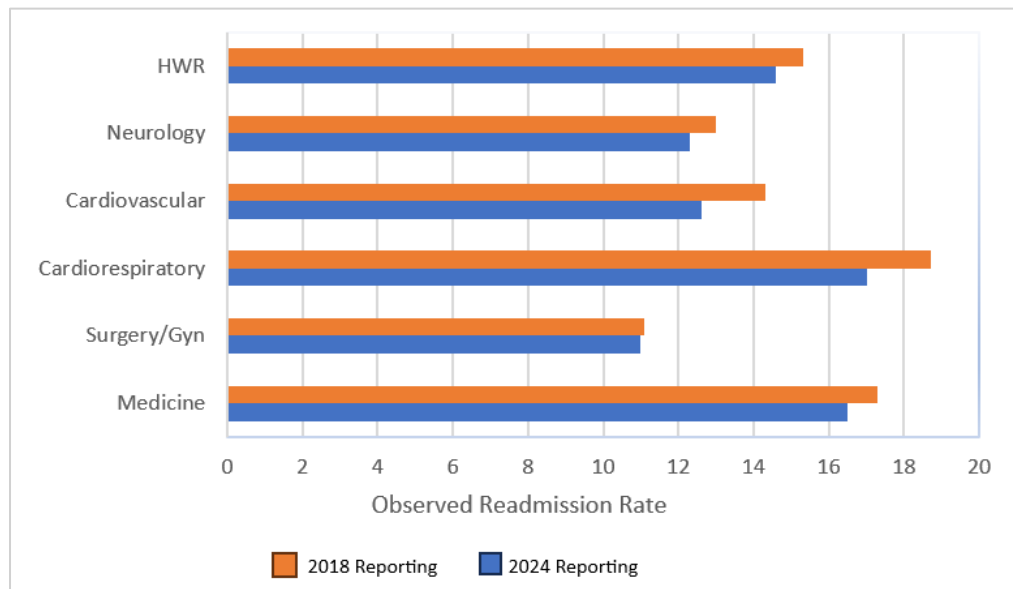


Table 20. Patient-Level Observed Readmission Rate (2024 and 2018 Reporting)

Cohort	2024 Reporting (discharges July 1, 2022—June 30, 2023)	2018 Reporting (discharges July 1, 2016—June 30, 2017)
Medicine	16.5	17.3
Surgical/Gynecological	11.0	11.1
Cardiorespiratory	17.0	18.7
Cardiovascular	12.6	14.3
Neurology	12.3	13.0
HWR	14.6	15.3

Figure 14. Hospital-Level Observed Outcomes: (2024 and 2018 Reporting)

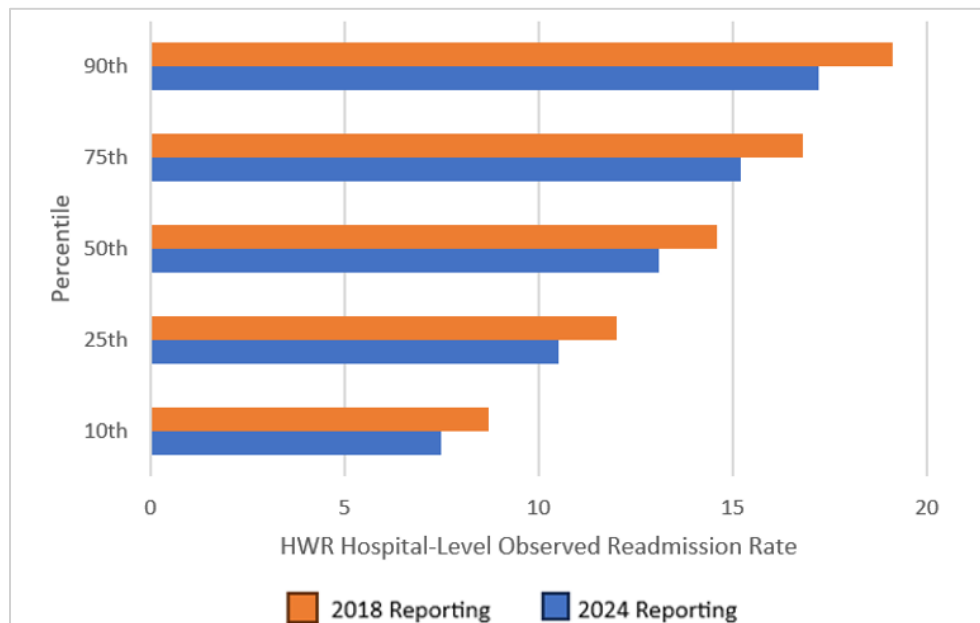


Table 21. Hospital-Level Observed Readmission Rate (2023 and 2018 Reporting)

Percentile	2024 Reporting (discharges July 1, 2022—June 30, 2023)	2018 Reporting (discharges July 1, 2016—June 30, 2017)
10th	7.5	8.7
25th	10.5	12.0
50th	13.1	14.6
75th	15.2	16.8
90th	17.2	19.1