

# Stroke Mortality Measure Submission to PQM: Figures and Tables

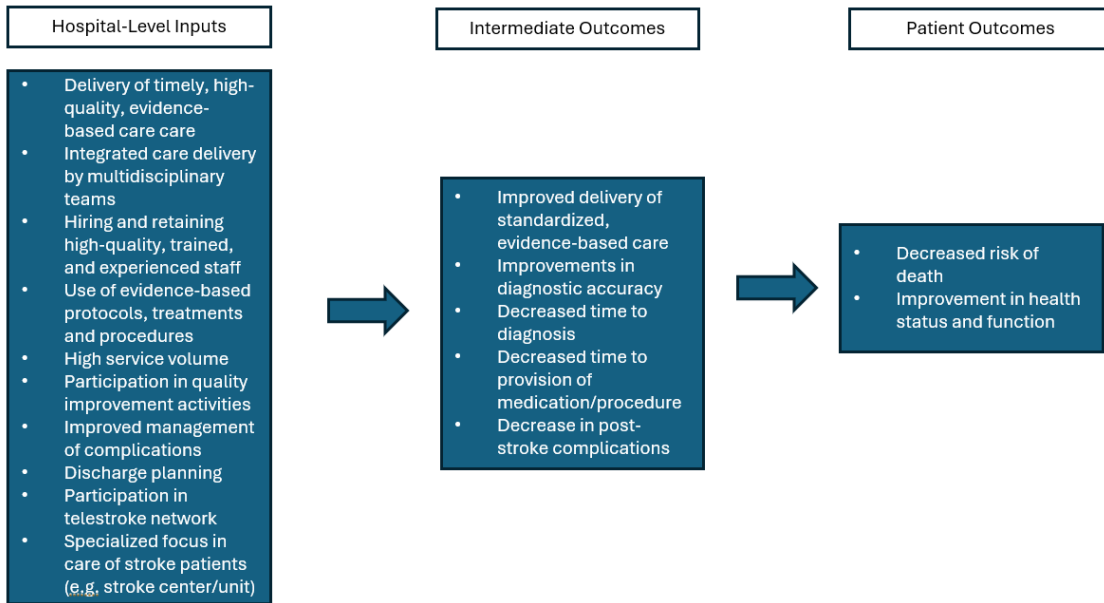
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**Figure 1. Stroke Mortality: Logic Model**

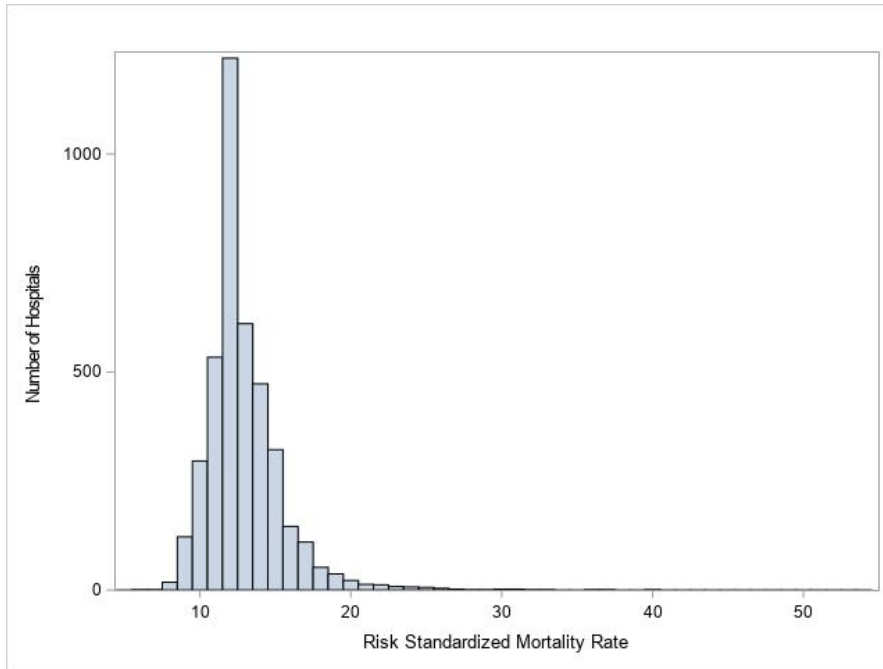


The diagram above shows the relationship between hospital-level inputs (such as the use of evidence-based protocols, and the delivery of high-quality, evidence-based treatments and procedures), intermediate outcomes (such as decreased time to provision of medications/procedures), and patient-level outcomes (decreased risk of death from stroke). The connection between these inputs, processes, and outcomes is discussed in Section 2.2 and Section 6.2.1.

**Table 1. Stroke Mortality: Hospital Distribution of Risk-Standardized Mortality Rates (RSMRs) (CY2022/2023 Data; January 1, 2021 - December 31, 2023)**

Category	January 1, 2021- December 31, 2023
Number of Hospitals	4,028
Mean (SD)	12.9 (2.6)
Range (Min. – Max.)	6.4 - 40.1
10th Percentile	10.4
25th Percentile	11.5
50th Percentile	12.4
75th Percentile	13.9
90th Percentile	15.7

**Figure 2. Stroke Mortality: Distribution of Stroke Risk-Standardized Mortality Rates (RSMRs) (n=4,028) (CY2022/2023 Data)**



**Table 2. Stroke Mortality: Performance Scores by Decile (CY2022/2023 Data)**

	Overall	Min	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10	Max
Mean Performance Score	12.92	6.43	9.66	10.88	11.52	11.95	12.26	12.56	13.18	13.92	14.90	18.37	40.28
N of Entities	4,028	1	402	403	403	403	403	403	403	403	403	402	1
N of Persons / Encounters / Episodes	573,699	107	116,218	96,188	70,250	46,694	28,125	51,057	54,761	43,443	34,753	32,210	29

**Table 3. Stroke Mortality: Dataset Descriptions**

Dataset	Type of Testing	Description of Dataset
<p><b>CY2022/2023:</b> 2-year Medicare Fee-for-Service (FFS) and Medicare Advantage (MA) dataset (January 1, 2022-December 30, 2023)</p>	<p>Reliability testing Validity testing Measure score distribution</p>	<p>Dates of Data: January 1, 2022-December 31, 2023</p> <p>Total number of hospitals (with at least 1 admission): 4,028</p> <p>Total number of admissions: 573,699</p> <p>Male (n=256,764), 44.8%</p> <p>Female (n=316,935), 55.2%</p> <p>Dual eligible (DE) (n=88,258), 15.4%</p> <p>High Area Deprivation Index (ADI) (n=0,917), 14.1%</p> <p>Total number of hospitals with at least 25 admissions: 2,473 (64% of total)</p> <p>Number of patients within facilities with at least 25 admissions: 275,203 (98%)</p>
<p><b>CY2022: 1-year MA+FFS Dataset:</b> 1-year Medicare FFS and Medicare Advantage Dataset (January 1, 2022-December 30, 2022)</p>	<p>Risk variable selection Risk variable frequencies and odds ratios Risk model performance Social risk factor testing Validity testing</p>	<p>Dates of Data: January 1, 2022-December 31, 2022</p> <p>Total number of hospitals (with at least 1 admission): 3,841</p> <p>Total number of admissions: 281,241</p> <p>Total number of hospitals with at least 25 admissions: 2,473 (64% of total)</p> <p>Number of patients within facilities with at least 25 admissions: 275,203 (98%)</p>
<p><b>CY2023: 1-year MA+FFS Dataset:</b> 1-year Medicare FFS and Medicare Advantage Dataset (January 1, 2023-December</p>	<p>Validation of model testing results</p>	<p>Dates of Data: January 1, 2023-December 31, 2022</p> <p>Total number of hospitals (with at least 1 admission):</p>

Dataset	Type of Testing	Description of Dataset
31, 2023)		3,841 Total number of admissions: 281,241 Total number of hospitals with at least 25 admissions: 2,473 (64% of total) Number of patients within facilities with at least 25 admissions: 275,203 (98%)
<b>2016-2019 FFS Dataset:</b> Medicare Fee-For-Service Administrative Claims Data (October 1, 2016 – June 30, 2019)	Data element validity testing (NIH Stroke Scale)	Dates of Data: October 1, 2016 – June 30, 2019 Number of admissions = 89,795 Patient Descriptive Characteristics: mean age = 79.5 years; % male = 44.8 Number of measured hospitals: 329
<b>American Heart Association/American Stroke Association (AHA/ASA)'s Get With The Guidelines (GWTG)-Stroke Registry</b>	Data element validity testing	Dates of Data: October 1, 2016 – December 31, 2019 We used NIH Stroke Scale scores from AHA/ASA's GWTG Stroke Registry data to validate the NIH Stroke Scale scores coded within administrative claims.

**Table 4. Stroke Mortality: Accountable Entity-Level Reliability Testing Results (CY2022/2023 Data) (Hospitals with >=25 Admissions)**

Minimum Case Volume	Min-Max	25 <sup>th</sup> Percentile	50 <sup>th</sup> Percentile	75 <sup>th</sup> Percentile
>= 1 Admission (n= 4,028)	0.062-0.994	0.373	0.778	0.927
>=25 Admissions (n= 2,473)	0.623-0.994	0.818	0.911	0.952

**Table 5. Stroke Mortality: Accountable Entity-Level Reliability Testing Results (CY2022/2023 Data) (Hospitals with >=25 Admissions)**

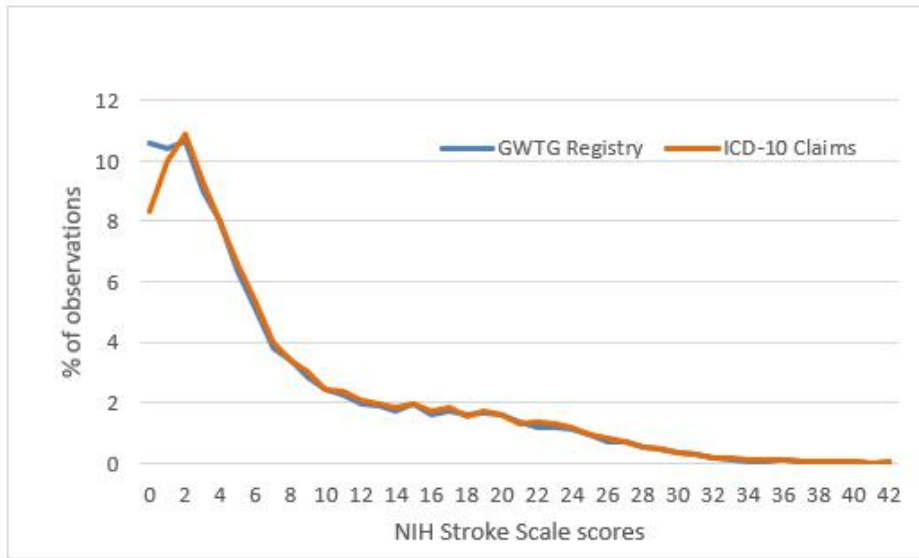
	Overall	Min	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10	Max
Reliability	0.875	0.623	0.668	0.749	0.816	0.865	0.898	0.919	0.937	0.953	0.966	0.979	0.994
Mean Performance Score	1.27	1.33	1.38	1.32	1.35	1.32	1.28	1.24	1.24	1.21	1.19	1.16	0.99
N of Entities	2,473	19	256	235	247	254	243	245	253	246	247	247	1
N of Persons / Encounters / Episodes	561,932	475	7,883	10,735	16,746	24,879	32,579	42,720	57,039	75,340	107,929	186,082	2,325

**Table 6. Stroke Mortality: List of Technical Expert Panel (TEP) Members**

Name, Credentials, and Professional Role	Organizational Affiliation, City, State
<b>Ann Borzecki, MD, MPH;</b> Attending Physician and Research Scientist	<ul style="list-style-type: none"> <li>VA Bedford Healthcare System, Bedford, VA</li> <li>Center for Healthcare Organization and Implementation Research, Bedford, MA</li> </ul>
<b>Sarah Brinkman, MBA, MA, CPHQ;</b> Quality Program Manager	<ul style="list-style-type: none"> <li>Stratis Health, Minneapolis, MN</li> </ul>
<b>Michael Duan, MS;</b> Principal Data Scientist	<ul style="list-style-type: none"> <li>Premier, Inc., Charlotte, NC</li> </ul>
<b>Richard Dutton, MD, MBA;</b> Anesthesiologist, Adjunct Professor, Chief Quality Officer	<ul style="list-style-type: none"> <li>Baylor University Medical Center</li> <li>Texas A&amp;M University</li> <li>US Anesthesia Partners, Dallas, TX</li> </ul>
<b>Ryan Merkow, MD, MS;</b> Surgical Oncologist, Health Services and Outcomes Researcher, Faculty Scholar	<ul style="list-style-type: none"> <li>Northwestern University, Surgical Outcomes and Quality Improvement Center</li> <li>American College of Surgeons, Division of Research and Optimal Patient Care, Chicago, IL</li> </ul>
<b>Matthias Cheung, RPh, PhD;</b> Adjunct	<ul style="list-style-type: none"> <li>University of the Pacific, Thomas</li> </ul>

Name, Credentials, and Professional Role	Organizational Affiliation, City, State
Professor of Pharmacy	J. Long School of Pharmacy, Stockton, CA <ul style="list-style-type: none"> <li>• Eversana Life Science Services, LLC, Chicago, IL</li> </ul>
<b>Lynn Stillman</b> , RN; Program Manager Payment Innovation	<ul style="list-style-type: none"> <li>• Elevance Health (formerly Anthem Blue Cross/Blue Shield of New Hampshire), Bedford, NH</li> </ul>
<b>Sachin Shah</b> , MD, MPH; Physician Scientist, Member of Faculty	<ul style="list-style-type: none"> <li>• Massachusetts General Hospital</li> <li>• Harvard Medical School, Boston, MA</li> </ul>
<b>Mary Vaughan-Sarrazin</b> , PhD; Associate Professor, Department of Internal Medicine, Director, Quantitative Unit of Health Services and Clinical Research Core, Investigator	<ul style="list-style-type: none"> <li>• University of Iowa</li> <li>• Iowa City VA Medical Center, Iowa City, IA</li> </ul>
<b>Thomas Webb</b> , MBA, PhD candidate; Associate Vice President of Quality Analytics	<ul style="list-style-type: none"> <li>• Rush University Medical Center, Chicago, IL</li> </ul>
<b>Bonnie Weiner</b> , MD, MSEC, MBA; Cardiologist, Professor of Medicine, Director Interventional Cardiology Research, Chief Medical Officer, Senior Medical Director	<ul style="list-style-type: none"> <li>• University of Massachusetts Medical School</li> <li>• Worcester Medical Center</li> <li>• Accreditation of Cardiovascular Excellence</li> <li>• Avania, Harvard, MA</li> </ul>
<b>Patient</b>	Virginia
<b>Patient</b>	Illinois

**Figure 3. Stroke Mortality: Correlation Between NIH Stroke Scale (NIHSS) Scores in ICD-10 Claims and Get With The Guidelines (GWTG) Registry (October 1, 2016-June 30, 2019)**



**Table 7. Stroke Mortality: Risk-Standardized Mortality Rates (RSMRs) within Deciles of Admission Volume (CY2022/2023 Data)**

Decile	Number of Hospitals	Range of Admissions within the Decile (Min-Max)	RSMR
1	428	1-2	12.9%
2	369	3-5	13.1%
3	417	6-12	13.6%
4	402	13-27	13.6%
5	402	28-53	13.5%
6	399	54-96	13.4%
7	405	97-158	12.8%
8	402	159-240	12.5%
9	402	241-412	12.2%
10	402	413-2,325	11.6%



**Table 8. Empiric Validity Testing: Association Between Stroke Mortality Measure Scores and Overall Hospital Star Ratings (Summary Score and Mortality Group Scores) (CY2022; Hospitals with at least 25 Admissions)**

Comparison of Stroke Mortality Measure Scores with:	Pearson Correlation Coefficient	p-value
Overall Summary Score (n=1,997)	-0.21	<0.001
Overall Summary Score without Entire Mortality Group (n=1,997)	-0.11	<0.001
Mortality Group Score (n=1,966)	-0.27	<0.001
Mortality Group Score without the FFS-only Stroke Mortality Measure (n=1,966)	-0.24	<0.001

**Table 9. Stroke Mortality: Risk Variable Frequencies, Odds Ratios (ORs) and 95% Confidence Intervals (CIs) (CY2022/2023 Data)**

Variable	Description	Frequency (%) (n= 573,699)	OR (95% CI)
AGE	Age, mean (SD)	78.7 (8.2)	1.04 (1.04 - 1.04)
	<b>ICD-10 codes during the index admission</b>		
A419	Sepsis, unspecified organism	1.03	1.72 (1.60 - 1.86)
C1	End stage renal disease or Dependence on renal dialysis	1.71	1.57 (1.45 - 1.69)
C787	Secondary malignant neoplasm of liver and intrahepatic bile duct	0.68	6.51 (5.95 - 7.11)
C7951	Secondary malignant neoplasm of bone	0.76	2.52 (2.30 - 2.76)
D631	Anemia in chronic kidney disease	3.31	0.93 (0.87 - 0.98)
E041	Nontoxic single thyroid nodule	1.31	0.66 (0.59 - 0.74)
E538	Deficiency of other specified B group vitamins	2.06	0.74 (0.68 - 0.81)
E785	Hyperlipidemia, unspecified	53.95	0.88 (0.86 - 0.90)
E870	Hyperosmolality and hyponatremia	1.66	1.61 (1.51 - 1.71)
E872	Acidosis	1.39	1.60 (1.49 - 1.72)
G43909	Migraine, unspecified, not intractable, without status migrainosus	1.25	0.62 (0.53 - 0.71)
G8101	Flaccid hemiplegia affecting right dominant side	0.79	1.86 (1.70 - 2.04)

Variable	Description	Frequency (%) (n= 573,699)	OR (95% CI)
G8104	Flaccid hemiplegia affecting left nondominant side	0.75	1.62 (1.47 - 1.79)
G8191	Hemiplegia, unspecified affecting right dominant side	18.57	1.24 (1.20 - 1.27)
G9340	Encephalopathy, unspecified	3.82	1.50 (1.43 - 1.56)
G9341	Metabolic encephalopathy	7.19	1.31 (1.26 - 1.36)
G9349	Other encephalopathy	3.55	1.42 (1.35 - 1.49)
G935	Compression of brain	1.25	2.15 (1.99 - 2.32)
G936	Cerebral edema	4.50	1.81 (1.73 - 1.89)
H518	Other specified disorders of binocular movement	0.86	1.24 (1.14 - 1.36)
I10	Essential (primary) hypertension	53.82	0.84 (0.82 - 0.86)
I214	Non-ST elevation (NSTEMI) myocardial infarction	1.42	2.03 (1.89 - 2.17)
I21A1	Myocardial infarction type 2	2.38	1.39 (1.31 - 1.47)
I2699	Other pulmonary embolism without acute cor pulmonale	0.70	1.57 (1.42 - 1.73)
I440	Atrioventricular block, first degree	1.94	0.77 (0.71 - 0.85)
I480	Paroxysmal atrial fibrillation	12.36	0.87 (0.85 - 0.90)
I4821	Permanent atrial fibrillation	1.55	0.94 (0.87 - 1.01)
I4892	Unspecified atrial flutter	2.30	0.90 (0.84 - 0.96)
I5022	Chronic systolic (congestive) heart failure	4.23	0.99 (0.94 - 1.04)
I5032	Chronic diastolic (congestive) heart failure	6.26	0.87 (0.84 - 0.91)
I609	Nontraumatic subarachnoid hemorrhage, unspecified	0.55	1.70 (1.52 - 1.89)
I671	Cerebral aneurysm, nonruptured	1.84	0.84 (0.77 - 0.92)
I951	Orthostatic hypotension	1.10	0.69 (0.61 - 0.78)
J189	Pneumonia, unspecified organism	1.89	1.59 (1.50 - 1.69)
J690	Pneumonitis due to inhalation of food and vomit	2.25	1.77 (1.68 - 1.87)
J90	Pleural effusion, not elsewhere classified	1.00	1.48 (1.37 - 1.60)
J9600	Acute respiratory failure, unspecified whether with hypoxia or hypercapnia	0.75	3.14 (2.89 - 3.43)
J9601	Acute respiratory failure with hypoxia	4.08	2.26 (2.17 - 2.36)
K7460	Unspecified cirrhosis of liver	0.58	1.52 (1.35 - 1.72)
N170	Acute kidney failure with tubular necrosis	0.65	1.84 (1.67 - 2.03)
Q211	Atrial septal defect	0.01	1.63 (0.63 - 4.23)
R1310	Dysphagia, unspecified	9.80	1.22 (1.18 - 1.25)
R260	Ataxic gait	0.82	0.58 (0.48 - 0.70)
R2681	Unsteadiness on feet	1.15	0.71 (0.61 - 0.82)

Variable	Description	Frequency (%) (n= 573,699)	OR (95% CI)
R2689	Other abnormalities of gait and mobility	1.18	0.72 (0.63 - 0.82)
R270	Ataxia, unspecified	3.77	0.72 (0.67 - 0.78)
R413	Other amnesia	0.51	0.60 (0.48 - 0.74)
R4189	Other symptoms and signs involving cognitive functions and awareness	0.80	0.72 (0.64 - 0.82)
R42	Dizziness and giddiness	1.68	0.57 (0.50 - 0.66)
R4701	Aphasia	25.28	1.05 (1.03 - 1.08)
R627	Adult failure to thrive	1.31	1.44 (1.34 - 1.54)
R64	Cachexia	1.01	1.58 (1.46 - 1.71)
R7303	Prediabetes	3.20	0.65 (0.60 - 0.70)
R778	Other specified abnormalities of plasma proteins	2.11	1.22 (1.14 - 1.31)
R911	Solitary pulmonary nodule	1.03	0.80 (0.71 - 0.91)
Z20822	Contact with and (suspected) exposure to COVID-19	36.08	0.84 (0.82 - 0.86)
Z515	Encounter for palliative care	9.38	22.81 (22.20 - 23.43)
Z66	Do not resuscitate	15.94	1.93 (1.88 - 1.98)
Z7401	Bed confinement status	1.13	1.20 (1.12 - 1.30)
Z751	Person awaiting admission to adequate facility elsewhere	0.60	0.35 (0.29 - 0.41)
Z7901	Long term (current) use of anticoagulants	16.50	0.94 (0.91 - 0.96)
Z7902	Long term (current) use of antithrombotics/antiplatelets	13.55	0.83 (0.80 - 0.86)
Z7982	Long term (current) use of aspirin	34.49	0.76 (0.74 - 0.79)
Z7984	Long term (current) use of oral hypoglycemic drugs	14.18	0.87 (0.83 - 0.90)
Z79890	Hormone replacement therapy	6.63	0.85 (0.81 - 0.90)
Z79899	Other long term (current) drug therapy	30.67	0.82 (0.79 - 0.84)
Z8673	Personal history of transient ischemic attack (TIA), and cerebral infarction without residual deficits	16.80	0.90 (0.87 - 0.93)
Z87891	Personal history of nicotine dependence	22.28	0.94 (0.91 - 0.97)
	<b>ICD-10 codes in the 12 months prior to admission</b>		
G459	Transient cerebral ischemic attack, unspecified	15.89	0.79 (0.76 - 0.82)
I63511	Cerebral infarction due to unspecified occlusion or stenosis of right middle cerebral artery	6.65	1.25 (1.20 - 1.30)

Variable	Description	Frequency (%) (n= 573,699)	OR (95% CI)
I63512	Cerebral infarction due to unspecified occlusion or stenosis of left middle cerebral artery	7.39	1.25 (1.21 - 1.30)
I6381	Other cerebral infarction due to occlusion or stenosis of small artery	6.55	0.81 (0.77 - 0.85)
I6521	Occlusion and stenosis of right carotid artery	6.29	1.13 (1.08 - 1.18)
J90	Pleural effusion, not elsewhere classified	8.38	1.25 (1.21 - 1.29)
M1711	Unilateral primary osteoarthritis, right knee	4.82	0.84 (0.80 - 0.89)
R202	Paresthesia of skin	4.88	0.86 (0.80 - 0.92)
R29818	Other symptoms and signs involving the nervous system	24.10	0.89 (0.86 - 0.91)
R4182	Altered mental status, unspecified	24.87	1.19 (1.16 - 1.22)
R4701	Aphasia	10.65	0.91 (0.88 - 0.94)
R634	Abnormal weight loss	3.76	1.34 (1.28 - 1.41)
R778	Other specified abnormalities of plasma proteins	5.52	1.20 (1.15 - 1.25)
Z1231	Encounter for screening mammogram for malignant neoplasm of breast	12.03	0.79 (0.76 - 0.82)
Z4682	Encounter for fitting and adjustment of non-vascular catheter	3.80	1.37 (1.31 - 1.43)
Z66	Do not resuscitate	6.60	1.16 (1.12 - 1.21)
	<b>ICD-10 codes either during the index admission or 12 months prior to admission</b>		
D696	Thrombocytopenia, unspecified	6.38	1.30 (1.25 - 1.35)
D72829	Elevated white blood cell count, unspecified	8.76	1.21 (1.17 - 1.25)
E119	Type 2 diabetes mellitus without complications	36.45	1.11 (1.08 - 1.14)
F0390	Unspecified dementia without behavioral disturbance	13.79	1.15 (1.12 - 1.18)
G8194	Hemiplegia, unspecified affecting left nondominant side	21.58	1.23 (1.19 - 1.26)
I4891	Unspecified atrial fibrillation	27.03	1.25 (1.21 - 1.28)
R000	Tachycardia, unspecified	6.74	1.14 (1.10 - 1.19)
R200	Anesthesia of skin	7.63	0.71 (0.67 - 0.75)
R471	Dysarthria and anarthria	21.82	0.88 (0.85 - 0.90)
R4781	Slurred speech	17.94	0.89 (0.87 - 0.92)
	<b>Other risk variables</b>		
MCCFI	Multiple Chronic Conditions Frailty Index	26.35	1.25 (1.22 - 1.28)

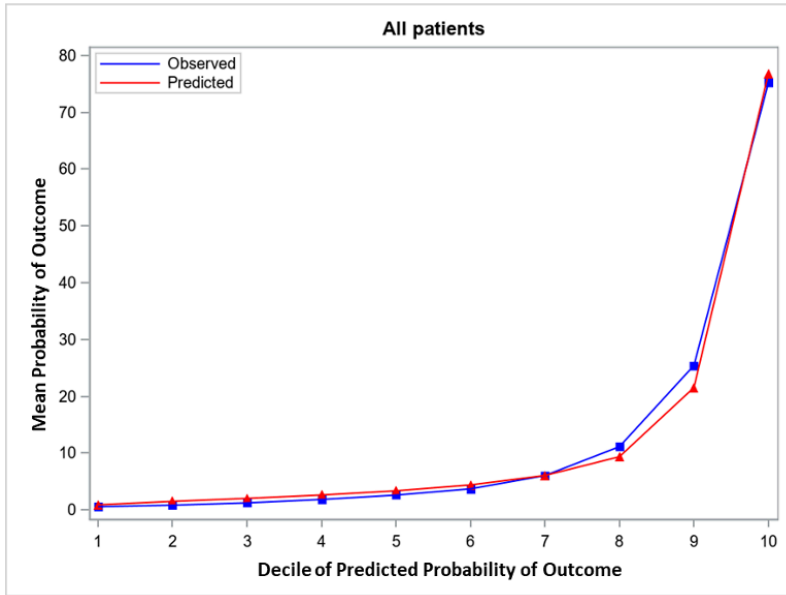
Variable	Description	Frequency (%) (n= 573,699)	OR (95% CI)
NIHSS	National Institutes of Health Stroke Scale (NIHSS), mean (SD)	6.67	1.04 (1.04 - 1.04)
HX_COVID	History of COVID-19	13.94	0.89 (0.87 - 0.92)
MA	MA (versus FFS)	51.45	0.93 (0.91 - 0.96)

**Table 10. Stroke Mortality: Model Performance (Predictive Ability, C-Statistics, Overfitting) (CY2022 Data)**

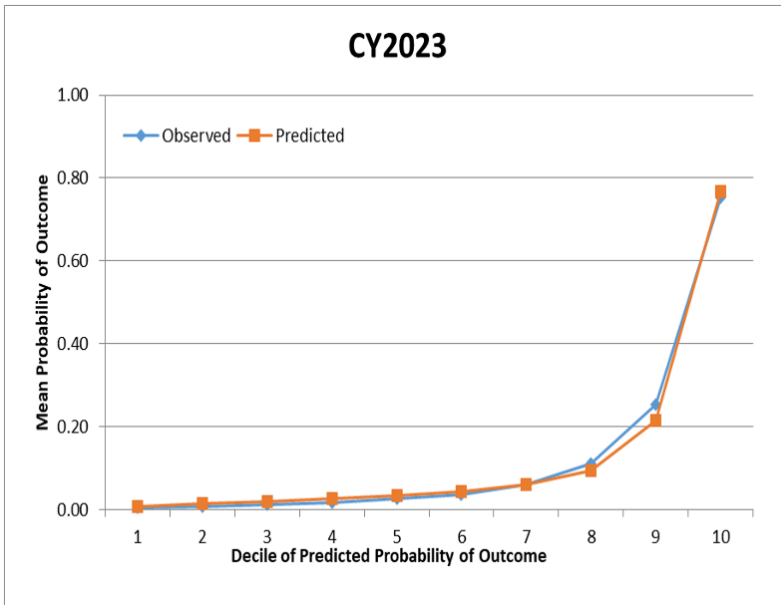
Value	Derivation	Validation
Predictive Ability, % (Lowest Decile – Highest Decile)	0.6% – 75.2%	0.5%-74.1%
C-statistic	0.911	0.915
Overfitting ( $\gamma_0$ , $\gamma_1$ )	0.000, 1.000	0.005, 0.997

Figure 4. Stroke Mortality: Calibration Plot (A) CY2022 (B) CY2023

A) CY2022



B) CY2023



**Table 11. Stroke Mortality: Variation in Prevalence of Social Risk Factors Across Measured Entities (CY2022 Data) (Hospitals with >=25 Admissions; n=2,033)**

Social Risk Factor	Median Prevalence (%) (25th Percentile-75th Percentile)
Dual Eligibility (DE)	12.6 (8.7 – 19.1)
High Area Deprivation Index (ADI) (>=85)	8.4 (1.7 – 22.9)

**Table 12. Stroke Mortality: Comparison of Observed Mortality Rate (%) Between Patients with and without Social Risk Factors (CY2022 Data)**

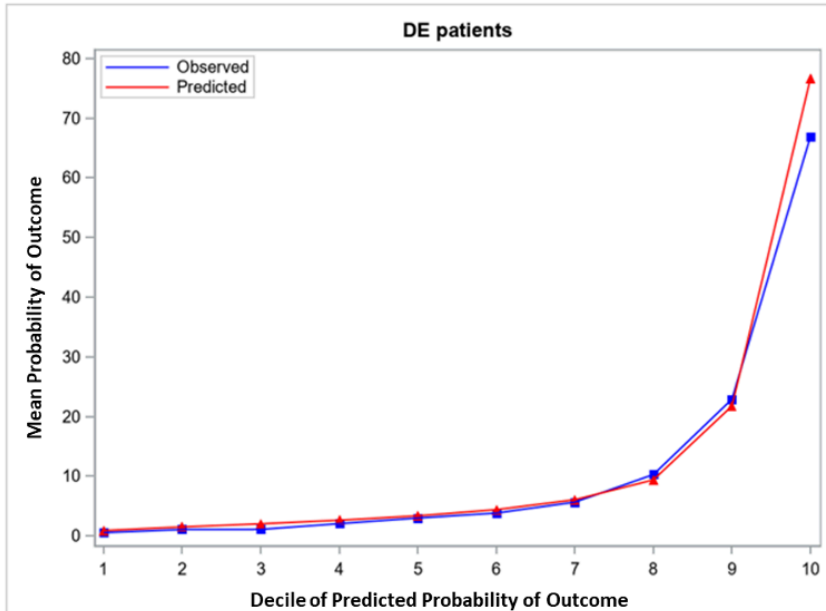
Social Risk Factor	Mean Observed Mortality Rate (%)
Dual Eligibility (DE)	14.1
Non-DE	12.6
High Area Deprivation Index (ADI) (>=85)	13.2
Low ADI (<85)	12.8

**Table 13. Stroke Mortality: Estimated Odds Ratio (OR) and 95% Confidence Interval (CI) of Social Risk Factor Variables (CY2022 Data)**

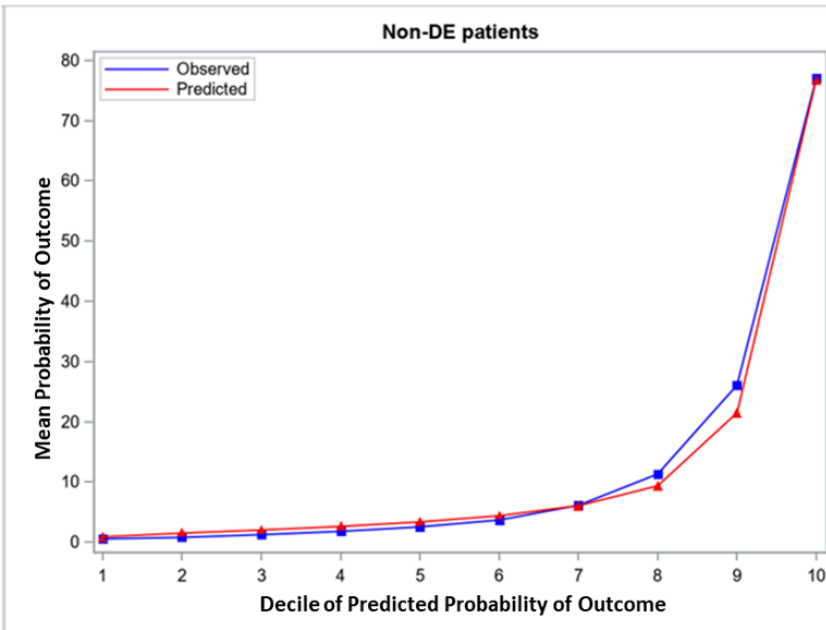
Social Risk Factor	OR (95% CI)
Dual Eligibility (DE)	0.79 (0.75, 0.82)
High Area Deprivation Index (ADI) (>=85)	1.20 (1.15, 1.25)

**Figure 5. Stroke Mortality: Calibration Plot for Patients (A) with the Dual Eligibility (DE) Variable and (B) without the DE Variable (CY2022 Data)**

**A) Dually Eligible Patients**



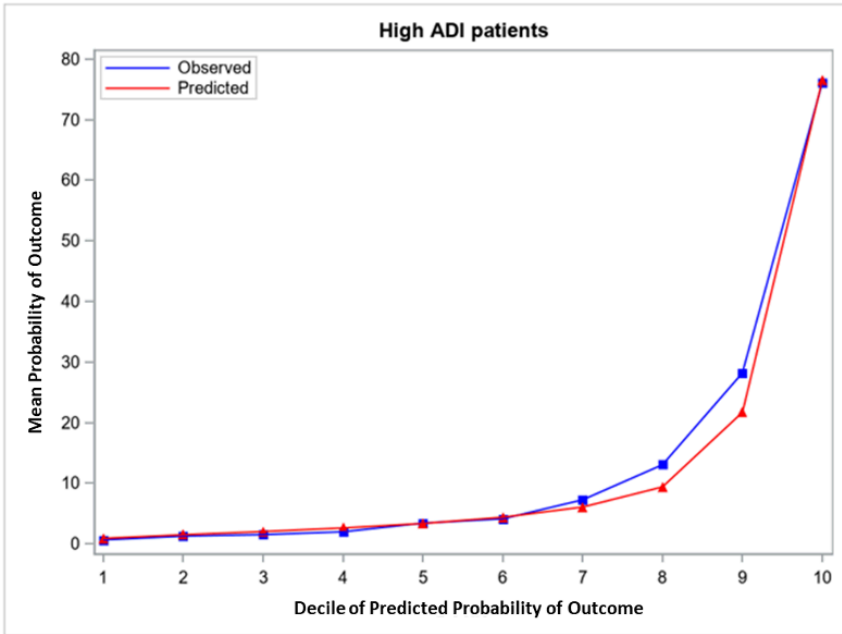
**B) Non-Dually Eligible Patients**



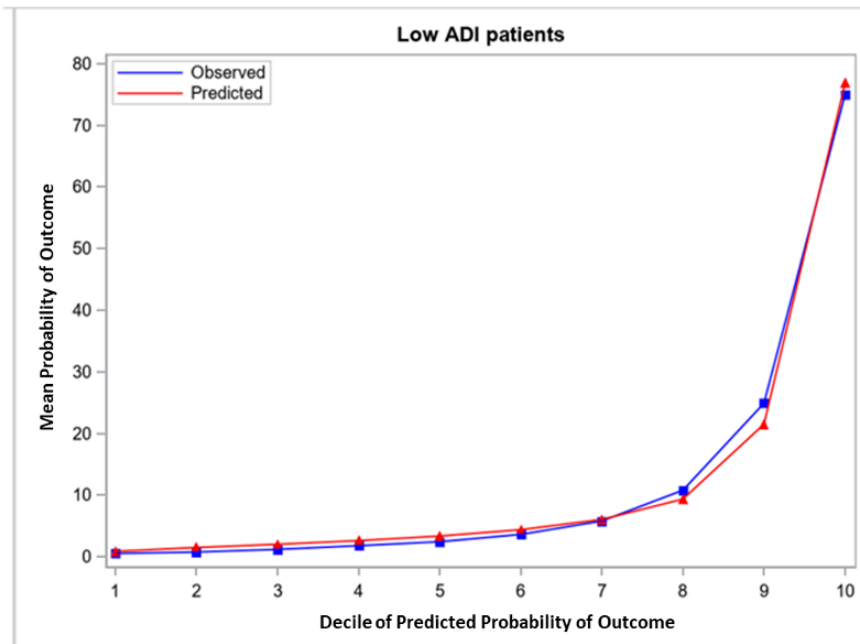


**Figure 6. Stroke Mortality: Calibration Plot for Patients (A) with the High Area Deprivation Index (ADI) Variable and (B) without the High ADI Variable (CY2022 Data)**

**A) Patients with High ADI ( $\geq 85$ )**



**B) Patients with Low ADI ( $< 85$ )**



**Table 14. Stroke Mortality: Differences in Measure Scores, and Correlation Between Measure Scores, for Measure Scores Calculated with and without Social Risk Factors (Dual Eligibility [DE] and High Area Deprivation Index [ADI]) (CY2022 Data)**

<b>Social Risk Factor</b>	<b>Median Difference in Measure Scores (%)</b>	<b>IQR (25th Percentile-75th Percentile)</b>	<b>Pearson Correlation Coefficient</b>
DE	-0.0002	-0.0005 - 0.0003	0.999
High ADI (>=85)	0.0006	-0.0006 - 0.0014	0.985