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In-Hospital/30-Day Stroke Mortality Risk Adjusted Rate Development, SPARCS, 2013

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Introduction

The burden of stroke in New York State (NYS) is significant. Annually strokes and transient ischemic attacks (TIAs) account for over 49,000 hospital discharges (SPARCS 2013). Stroke remains the fourth leading cause of death in NYS, accounting for about 6,000 deaths annually (2013 Vital Statistics)[1]. While rates of stroke mortality have declined significantly in NYS in the past decade, nearly fifteen percent of adults hospitalized for stroke in NYS die in the hospital or within 30 days of their admission. However, there is a considerable variation in stroke mortality rates between hospitals. A risk-adjusted mortality rate model was developed to account for differences in patient characteristics and to enable meaningful stroke mortality rate comparisons across hospitals in NYS.

Public Reporting

The purpose of this work was to calculate hospital-specific risk-adjusted stroke mortality rates (RAMR) to inform hospitals, to aid initiatives to improve hospital quality, performance, and measurement, and to identify performance outliers for public reporting. This work represents efforts at quality improvement for stroke care that have resulted from the NYS Stroke Designation Center program as well as opportunities for designated and non-designated hospitals to use administrative data for further improvement.

Stroke Designation

Since 2004, the New York State Department of Health (NYSDOH) has been designating hospitals as stroke centers. Designation is a voluntary program requiring compliance with criteria

Highlights

- Overall, in 2013, risk adjusted stroke mortality rates were significantly lower for stroke designated hospitals than for hospitals without designated status (13.76% vs 16.41%)
- In 2013, seven NYS hospitals were identified as top performers with the RAMR being statistically different from the statewide mortality rate
- Almost one fifth (19.7%) of those who died post stroke admission, died in hospice
- Stroke mortality risk adjustment model developed on NYS all payer data performed as well as model developed on a national data set
- APR-DRGs with ROM are very strong predictors for stroke mortality

developed from the Brain Attack Coalition Guidelines for Primary Stroke Centers [2] centering around eleven major aspects of care: acute stroke teams, written care protocols, emergency medical services, Emergency Department, stroke unit, neurosurgical services, commitment and support of the Medical organization, neuroimaging services, lab services, community education, outcomes and quality improvement activities. Hospitals wishing to become designated submit completed applications to the NYSDOH which are reviewed by the Central Office and Regional Office staff. Recommendations are submitted to the Public Health and Health Planning Council and on site reviews are performed. In calendar year (CY) 2013 there were 116 hospitals with stroke center designation in NYS.

Data Sources

This study was completed using the administrative data sources available to the research staff in the NYSDOH. Hospital inpatient discharges were obtained from the Statewide Planning and Research Cooperative System (SPARCS). SPARCS is a comprehensive data reporting system established in 1979 as a result of cooperation between the health care industry and government. Initially created to collect information on discharges from hospitals, SPARCS currently collects patient-level detail on patient characteristics, diagnoses and treatments, services, and charges for every Article 28 (acute care) inpatient hospital discharge, ambulatory surgery, emergency department visit, and visits to hospital-based outpatient clinics in New York State.

Hospital inpatient discharges in the CY 2013 were linked to the New York State Vital Statistics (VS) records to supplement in-hospital mortality data. This linkage allowed us to extend the follow-up period and to account for deaths occurring within 30 days post admission or in a hospice.

Methods

Study Population

The study population was defined based on the methodology developed by the Agency for Healthcare Research and Quality (AHRQ) to calculate the Inpatient Quality Indicators (IQI) related to stroke mortality[3]. The study population included all hospital discharges with a primary diagnosis of stroke in CY 2013 from all NYS Article 28 hospitals. The list of the ninth revision of the International Classification of Diseases, Clinical Modification (ICD-9-CM) diagnoses for the three types of stroke examined in this study (Ischemic, subarachnoid hemorrhagic, and intracerebral hemorrhagic) is presented in Table 1. The hemorrhagic stroke definition was revised from the AHRQ diagnoses list and only ICD-9-CM code 431: “Intracerebral Hemorrhage” was included. This was in consensus with the NYS stroke physicians advisory workgroup to include only non-traumatic hemorrhage cases in this study. In alignment with the AHRQ methods, the discharges with characteristics such as patient being under 18 years of age, transfer to another short-term hospital, those with Major Diagnostic Category (MDC) 14 (pregnancy, childbirth, and puerperium), and discharges with missing data on disposition, gender, and age were removed from the analysis.

Additional exclusions were applied by the NYSDOH. To reduce bias related to misclassification of the 30-day mortality outcome in cases when a stroke patient was an out-of-state resident, discharges for those patients were removed from the analysis. Discharges with primary diagnosis of stroke when the patient was admitted from hospice or cases with an elective admission were also excluded from this study. Additionally, stroke discharges within 30 days post initial stroke were removed from the analysis. To establish that none of the CY 2013 discharges with primary diagnosis of stroke occurred within a 30-day window post previous stroke discharge, CY 2012 stroke discharges were examined as well.

The final analysis cohort had inpatient hospital discharges with a primary diagnosis of stroke from 184 hospitals in NYS. A majority of the hospitals had stroke designation status: 116 (63%) stroke center designations vs 68 (37%) non stroke center designations.

Outcome

The aim of this retrospective cohort study was to estimate a facility-level risk adjusted in-hospital/30-day all-cause mortality rate post acute stroke admission. This was achieved through aggregation of the patient-level mortality outcome to a facility-level mortality rate. The in-hospital/30-day mortality outcome measure is a composite measure and was defined as one of the following: (1) in-hospital death during the stroke admission; (2) death within 30 days post inpatient admission for stroke; (3) cases when a patient who was admitted for an acute stroke, was discharged to hospice care and died within 30 days post admission to hospice directly from initial hospital discharge. The composition of the outcome is shown in Table 2.

Analysis and Model Selection

The approach to risk adjustment in this study followed the methodological principles that were outlined by Krumholz et al. in the American Heart Association Scientific Statement "Standards for Statistical Models Used for Public Reporting of Health Outcomes"[4]. To accurately assess hospital-level mortality taking into account patient case-mix and to create a valid measure that would allow for meaningful comparison across hospitals, a risk adjustment methodology with indirect standardization was employed. Similar to AHRQ's methods for IQIs, a multivariate logistic regression model was developed using inpatient hospital discharges reported to SPARCS [5]. The model performance was assessed using the concordance statistic (c-statistic) [6].

While only patient-level predictors were left in the final model, many patient and facility-specific parameters that are available in the SPARCS data were examined. Statewide crude in-hospital/30-day all-cause mortality rates were calculated within all levels of the parameters to aid in understanding the study population. This extensive preliminary work helped to create a robust data set for further analysis.

Risk adjustment model predictors were limited to patient-level risk factors such as demographic characteristics (age, gender, race) and All Patient Refined Diagnosis Related Groups (APR DRGs) with corresponding risk of mortality (ROM). APR DRG is a system developed by 3M™ that classifies hospitalized patients according to their reason of admission, procedures performed, severity of illness and risk of mortality[7]. There are four levels of ROM for each APR DRG, with higher risk of mortality being characterized by multiple serious diseases and the interaction of those diseases. In this analysis, ROM was assigned considering only those diseases and conditions that were present on admission and were not a result of complications of care. An additional logistic regression model (not shown) was developed with Elixauser [8] comorbidities as the main risk factors in place of the APR DRGs. The model performance was not as good as with use of the APR DRGs (c-statistic 0.70 vs 0.87).

Results

Descriptive Statistics

There were about 2.4 million inpatient hospital discharges from Article 28 hospitals in NYS. Discharges with primary diagnosis of stroke accounted for 1.3% or 31,264 discharges. After all specified exclusions, the analysis data set had 28,143 acute stroke discharges with a majority of them having a primary diagnosis of ischemic stroke (83.23%). Intracerebral hemorrhagic and subarachnoid stroke accounted for 12.09% and 4.68%, respectively (Table 3). The overall statewide mortality rate was 14.01% translating into 3,943 discharges. The stroke type-specific crude mortality rate was the highest for those admitted with intracerebral hemorrhagic stroke (33.86%), while the crude mortality rate for ischemic stroke was 10.56%. Out of all deaths, 63.56% happened in-hospital (Table 2). Deaths that occurred within 30 days post initial stroke admission, but after the discharge accounted for 35.2% of all deaths and were distributed similarly between those discharged to hospice and died within 30 days post hospital admission (18.4%), and those discharged home

or to other facilities (16.8%). Fifty patients or 1.3% of all stroke deaths occurred in hospice 30 days post admission to the hospice.

The distribution and crude stroke mortality rates for the study population stratified by multiple patient and hospital level characteristics are presented in Table 3. There were slightly more females than males (52.33% vs 47.67%) admitted with a primary diagnosis of stroke in CY 2013. For patients under the age of 60 (22.84% of all stroke patients), the crude stroke mortality rate was below 8%. The number of patients with stroke admitted to the hospital increased with age up to the age of 90 when it sharply declined to 9.53% of the stroke cohort. Most of the stroke discharges (67.63%) were for patients between the ages of 60 and 90. The age-specific mortality rate increased after the age of 50 and was the highest in the 90 and older age group (30.82%).

More than half (56.77%) of all stroke patients were non-Hispanic Whites. This race/ethnicity group also had the highest mortality rate of 16.59%. Non-Hispanic Black patients had the lowest crude mortality rate (9.54%) while being the second largest group (19.26%) of all stroke patients who were admitted to hospital.

An overwhelming majority (93.49%) of stroke discharges were from stroke designated centers. At the same time, the crude stroke mortality for the discharges from stroke designated hospitals was lower than for discharges from non-designated hospitals (13.87% vs 16.00%, respectively). Similar trends were noted for the hospitals with teaching status: overall mortality was lower for discharges from teaching hospitals than for non-teaching hospitals (13.56% vs 16.45%, respectively).

Sixty-four percent of the stroke patients were discharged from the hospital between two and seven days post admission. This length of stay (LOS) was associated with the lowest stroke mortality rate of 11.25%. Discharges with the LOS of one day, which accounted for 7.77% of stroke discharges, had a mortality rate of 32.14% - the highest crude mortality rate across all LOS groups.

The source of admission for the majority of the stroke discharges (84.37%) was from non-health care facilities. Under eight percent (7.79%) of discharges were transfers from other hospitals. Transfers from any kind of long-term-care facility accounted for 2.70% of stroke discharges and had the highest mortality rate of 32.59%. Close to 90% of the stroke discharges come through the Emergency Department (ED); this was also associated with a lower mortality rate: 14.34% vs 18.14% for non-ED admissions.

The top three discharge destinations for stroke cases were home (29.90%), skilled nursing facility (22.87%), and inpatient rehabilitation facility (18.42%). The crude mortality rates by discharge destination were highest for discharges to institutional (84.24%) and to home-based (64.65%) hospice, then for discharges to long-term-care hospitals (15.48%) and to other types of facilities (7.63%). The lowest mortality rates were for patients who were discharged home or to home with home health care and for those who left against medical advice (0.75%, 1.50% and 0.34%, respectively). Almost one fifth (18.42%) of stroke patients were discharged to inpatient rehabilitation facilities and had one of the lowest mortality rates (1.23%).

Distribution of the stroke patients across APR-DRGs and ROM levels was in part determined by the distribution across stroke types with 78.04% falling into the APR-DRG 045: "CVA and Pre Cerebral Occlusion with Infarction". The crude mortality rate within each APR-DRG increased dramatically with the increase in risk of mortality (ROM).

Risk Adjustment Model

A logistic regression model was fit to the analysis data set. Stepwise backwards selection was used in determining the most parsimonious model. The final risk adjustment model is described in Table 4. All but one predictor (Age: 50-59) retained in the model were significant at a 0.001 level showing strong association with the outcome. Some of the ROM levels within one APR-DRG had to be combined due to the small number of

discharges in the individual ROM stratum. The adjusted odds ratios increased with the advancing of the patient's age and especially with the increase in the level of risk of mortality.

Comparing the c-statistic for the risk adjustment model developed by AHRQ on CY 2010 national sample from Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID) that represented more than 95% of all annual discharges in the US [5], to the c-statistic for the model developed using only NYS all payer hospital discharges, it is evident that NYS' risk adjustment model performs very well. Corresponding values for the c-statistic were 0.89 for AHRQ and 0.87 for the NYS model.

Hospital-Specific Risk Adjusted Mortality Rates

Risk adjusted in-hospital/30-day mortality rates per 100 stroke admissions at risk for each facility were calculated using the method of indirect standardization that is described by the following formula:

$$RAMR = [(OMR/EMR)*SMR]*100$$

RAMR – risk adjusted mortality rate per 100 admissions at risk
OMR – hospital's observed mortality rate
EMR – hospital's expected mortality rate (sum of all individual patient's probabilities of mortality outcome based on the risk adjustment model)
SMR – statewide observed mortality rate – reference population rate

The risk adjusted mortality rate is interpreted as an estimate of what the mortality rate for this hospital would be if the hospital's patient case-mix was the same as the statewide patient case-mix. Risk adjustment allows one to account for differences in patient characteristics and to concentrate on the hospital's quality of care provided for stroke patients. To compare hospitals RAMR to the SMR, 95% gamma-distribution-based confidence intervals were calculated around each hospital's RAMR [9].

To avoid presenting possibly unstable RAMR estimates due to a small sample size, facility-specific RAMR are reported only for the hospitals with 30 or more stroke cases in CY 2013. Out of 184 hospitals with at least one stroke discharge in CY 2013, 136 hospitals met that criteria with stroke designated hospitals being a majority: 115 designated vs 21 not designated (Table 5). Overall, relative to the statewide average, there were seven top (better) and eight bottom (worse) performing hospitals identified among hospitals with 30 or more stroke discharges in CY 2013. Table 5 presents statewide stroke RAMR stratified by hospital stroke designation status. It illustrates that in both cases: stroke discharges from all hospitals and for stroke discharges from facilities with 30 or more stroke cases, RAMR for non-stroke designated hospitals are significantly higher than statewide stroke mortality. For hospitals with any number of stroke discharges in CY 2013, RAMR for stroke designated centers was significantly lower than for not designated (13.76; 95% CI, 13.32-14.21 vs 18.10; 95% CI, 16.08-20.29). The relationship's directionality still holds for hospitals with 30 or more stroke discharges (13.76; 95% CI, 13.32-14.21 vs 16.41; 95% CI, 14.15-18.92).

Figure 1 shows NYS Article 28 hospitals that had 30 or more discharges with a primary diagnosis of stroke. It is a graphic representation of the facility-specific RAMR for stroke inpatient discharges in CY 2013 complete with the 95th lower and upper percentiles and statewide mortality rate. It illustrates the differences in hospital's RAMR, shows top and bottom performers (when compared to the expected performance of an average provider that has the same case mix, i.e. the statewide case mix) and highlights the performance of stroke designated and not designated hospitals.

Conclusions

The purpose of this work is to provide hospitals and the public with the risk adjusted mortality outcome measure to inform all stakeholders about hospital-level stroke mortality, to initiate a discussion about the quality of care for this devastating disease and to improve patient outcomes. To enable a meaningful comparison a method of risk adjustment was used that allowed for the patient's conditions at the time of admission for stroke to be accounted for. This work illustrates that stroke designation status does have an effect on stroke mortality outcomes. While RAMR for stroke designated hospitals varied significantly across the state and contributed to groups of better and worse performers, the overall stroke mortality rate was lower for the stroke designated hospitals. The NYSDOH will continue to develop risk adjustment methodology, to report on stroke mortality, and publish calculated rates on Health Data NY and on the NYS Hospital Profile websites [10, 11].

Tables and Figures

Table 1. ICD-9-CM Codes Used in Identification of Stroke Discharges

Stroke Type	ICD-9 Code	Code Description
Subarachnoid	430	Subarachnoid hemorrhage
Hemorrhagic	431	Intracerebral hemorrhage
Ischemic	433.01	Occlusion and stenosis of basilar artery with cerebral infarction
	433.11	Occlusion and stenosis of carotid artery with cerebral infarction
	433.21	Occlusion and stenosis of vertebral artery with cerebral infarction
	433.31	Occlusion and stenosis of multiple and bilateral precerebral arteries with cerebral infarction
	433.81	Occlusion and stenosis of other specified pre cerebral artery with cerebral infarction
	433.91	Occlusion and stenosis of unspecified pre cerebral artery with cerebral infarction
	434.01	Cerebral thrombosis with cerebral infarction
	434.11	Cerebral embolism with cerebral infarction
	434.91	Cerebral artery occlusion, unspecified with cerebral infarction

Table 2. Outcome Composition: Timing of Death, Inpatient Discharges with Primary Diagnosis of Stroke, SPARCS, 2013

Timing of Death	(N)	Of Total (%)
In-Hospital	2,506	63.56
30-Days Post Stroke Admission, not in Hospice	662	16.79
In Hospice, 30-Days Post Stroke Admission	725	18.39
In Hospice, 30-Day Post Admission to Hospice	50	1.27
Total	3,943	100.00

Table 3. Descriptive Statistics, Inpatient Discharges with Primary Diagnosis of Stroke, SPARCS, 2013

	All Stroke Discharges		Died				
	(N)	(%)	(N)	Of Total (%)	Within Group (%)	Odds Ratio[1]	p
All Stroke Discharges	28,143	100.00	3,943	100.00	14.01		
Stroke Type[2]							
Subarachnoid Stroke	1,317	4.68	317	8.04	24.07	2.68	***
Hemorrhagic Stroke	3,402	12.09	1,152	29.22	33.86	4.34	***
Ischemic Stroke	23,424	83.23	2,474	62.74	10.56	Ref	
Gender							
Female	14,727	52.33	2,351	59.62	15.96	1.41	***
Male	13,416	47.67	1,592	40.38	11.87	Ref	
Age, Years							
18-29	199	0.71	12	0.30	6.03	Ref	
30-39	489	1.74	36	0.91	7.36	1.24	0.535
40-49	1,736	6.17	122	3.09	7.03	1.18	0.601
50-59	4,003	14.22	304	7.71	7.59	1.28	0.416
60-69	5,554	19.73	462	11.72	8.32	1.41	0.251
70-79	6,357	22.59	772	19.58	12.14	2.15	**
80-89	7,122	25.31	1,408	35.71	19.77	3.84	***
90+	2,683	9.53	827	20.97	30.82	6.94	***
Race / Ethnicity							
Asian, Native Hawaiian, Pacific Isl., NH	974	3.46	122	3.09	12.53	0.72	***
Black, NH	5,421	19.26	517	13.11	9.54	0.53	***
Hispanic	2,790	9.9	303	7.7	10.9	0.61	***
Native American, Alaskan Native, NH	83	0.29	9	0.23	10.84	0.61	0.165
Other, NH	2,897	10.29	342	8.67	11.81	0.67	***
White, NH	15,978	56.77	2,650	67.21	16.59	Ref	
Stroke Designated Center							
Yes	26,312	93.49	3,650	92.57	13.87	0.85	*
No	1,831	6.51	293	7.43	16.00	Ref	
Teaching Hospital							
Yes	23,779	84.49	3,225	81.79	13.56	0.80	***
No	4,364	15.51	718	18.21	16.45	Ref	
Length of Stay, Days							
1	2,187	7.77	703	17.83	32.14	3.74	***
2 to 7	18,154	64.51	2,043	51.81	11.25	Ref	
8 to 14	4,923	17.49	785	19.91	15.95	1.50	***
15 to 21	1,456	5.17	224	5.68	15.38	1.43	***
22 to 30	751	2.67	106	2.69	14.11	1.30	*
31 +	672	2.39	82	2.08	12.20	1.10	0.446

	All Stroke Discharges		Died				
	(N)	(%)	(N)	Of Total (%)	Within Group (%)	Odds Ratio[1]	p
Source of Admission							
Non-Health Facility	23,745	84.37	3,135	79.51	13.20	Ref	
Transfer from Acute Care Facility	2,193	7.79	383	9.71	17.46	1.39	***
Transfer from Clinic	913	3.24	113	2.87	12.38	0.93	0.469
Transfer from SNF or ICF	761	2.70	248	6.29	32.59	3.18	***
Transfer from Other Facility	196	0.70	31	0.79	15.82	1.24	0.283
No information	335	1.19	33	0.84	9.85	0.72	0.073
ER Indicator							
Yes	27,645	89.88	3,964	87.52	14.34	0.85	**
No	3,114	10.12	565	12.48	18.14	Ref	
Discharge Status							
Home	8,414	29.90	63	1.60	0.75	Ref	
Home with Home Health Care	3,939	14.00	59	1.50	1.50	2.02	***
Long Term Care Hospital	168	0.60	26	0.66	15.48	24.28	***
Skilled Nursing Facility	6,435	22.87	431	10.93	6.70	9.52	***
Inpatient Rehabilitation Facility	5,184	18.42	64	1.62	1.23	1.66	**
Other Facility	236	0.84	18	0.46	7.63	10.94	***
Left Against Medical Advice	291	1.03	1	0.03	0.34	0.46	0.438
Hospice: Institutional	755	2.68	636	16.13	84.24	NotEst.	
Hospice: Home	215	0.76	139	3.53	64.65	NotEst.	
Died in Hospital[3]	2,506	8.90	2,506	63.56	100.00	NotEst.	
Primary Payer							
Medicare	18,523	65.82	3,138	79.58	16.94	2.55	***
Medicaid	3,788	13.46	327	8.29	8.63	1.18	*
Other	534	1.90	71	1.80	13.30	1.92	***
Private	4,656	16.54	345	8.75	7.41	Ref	
Self Pay	642	2.28	62	1.57	9.66	1.34	*
APR-DRG and ROM[4]							
APR-021-1-Craniotomy Except Trauma	135	0.48	8	0.20	5.93	9.25	***
APR-021-2	63	0.22	9	0.23	14.29	24.48	***
APR-021-3	493	1.75	136	3.45	27.59	55.96	***
APR-021-4	224	0.80	140	3.55	62.50	244.83	***
APR-022-1-Ventricular Shunt Procedures	1	0.00	1	0.03	100.00	-	-
APR-022-2	-	-	-	-	-	-	-
APR-022-3	1	0.00	-	-	-	-	-
APR-022-4	27	0.10	9	0.23	33.33	73.45	***
APR-024-1-Extracranial Vascular Procedures	104	0.37	-	-	-	-	-
APR-024-2	606	2.15	31	0.79	5.12	7.92	***
APR-024-3	162	0.58	26	0.66	16.05	28.08	***
APR-024-4	46	0.16	16	0.41	34.78	78.35	***
APR-026-1-Other Nervous System & Related Procedures	3	0.01	-	-	-	-	-

	All Stroke Discharges		Died				
	(N)	(%)	(N)	Of Total (%)	Within Group (%)	Odds Ratio[1]	p
APR-026-2	99	0.35	5	0.13	5.05	7.81	***
APR-026-3	50	0.18	4	0.10	8.00	12.77	***
APR-026-4	13	0.05	3	0.08	23.08	44.07	***
APR-044-1-Intracranial Hemorrhage	-	-	-	-	-	-	-
APR-044-2	1,582	5.62	164	4.16	10.37	16.99	***
APR-044-3	883	3.14	249	6.31	28.20	57.69	***
APR-044-4	922	3.28	738	18.72	80.04	589.19	***
APR-045-1-CVA & Pre Cerebral Occlusion W/ Infarction	7,247	25.75	49	1.24	0.68	Ref	
APR-045-2	9,956	35.38	771	19.55	7.74	12.33	***
APR-045-3	3,442	12.23	731	18.54	21.24	39.61	***
APR-045-4	1,317	4.68	736	18.67	55.88	186.09	***
Other	767	2.73	117	2.97	15.25	26.44	***

1 – Bivariate Odds Ratio
2 – For stroke type definitions refer to Table 1.
3 – Number of died in hospital and number of stroke discharges is not the same as length of stay could be > 30 days.
4 – APR-DRG and ROM – All Patients Refined Diagnosis Related Groups and risk of mortality was assigned using 3M limited license grouper, with Present on Admission Indicator taken into account.
p-value:
* - $p < 0.05$
** - $p < 0.01$
*** - $p < 0.001$

Table 4. In-Hospital/30-Day Stroke Mortality Risk Adjustment Model, SPARCS, 2013

Patient Risk Factors	Prevalence (%)	Regression Coefficient	Odds Ratio	Odds Ratio 95% Lower CI	Odds Ratio 95% Upper CI	p[2]
Age, Years						
18-49	8.61		Ref			
50-59	14.22	0.380	1.46	1.15	1.86	**
60-69	19.73	0.604	1.83	1.46	2.29	***
70-79	22.59	0.877	2.40	1.93	2.99	***
80-89	25.31	1.409	4.09	3.30	5.08	***
90+	9.53	2.199	9.01	7.17	11.33	***
Race						
White, NH	56.77	0.373	1.45	1.33	1.59	***
All Other	43.23		Ref			
APR-DRG with ROM						
APR-021-1-Craniotomy Except For Trauma[3]	0.48	2.464	11.75	5.43	25.42	***
APR-021-2	0.22	3.354	28.61	13.31	61.52	***
APR-021-3	1.75	3.983	53.69	37.92	76.01	***
APR-021-4	0.80	5.593	268.63	180.48	399.83	***
APR-022-1-4-Ventricular Shunt Procedures	0.10	4.554	94.98	41.30	218.40	***
APR-024-1-2-Extracranial Vascular Procedures	2.52	1.567	4.79	3.03	7.59	***
APR-024-3	0.58	2.894	18.06	10.80	30.21	***
APR-024-4	0.16	4.151	63.48	31.75	126.92	***
APR-026-1-4-Other Nervous System & Related Proc.	0.59	1.774	5.89	3.04	11.43	***
APR-044-1-2-Intracranial Hemorrhage	5.62	2.379	10.80	7.77	15.02	***
APR-044-3	3.14	3.403	30.05	21.71	41.59	***
APR-044-4	3.28	6.111	450.66	324.72	625.44	***
APR-045-1-CVA & Pre-Cerebral Occl. W/ Infarction	25.75		Ref			
APR-045-2	35.38	1.658	5.25	3.886	7.09	***
APR-045-3	12.23	2.825	16.86	12.463	22.81	***
APR-045-4	4.68	4.644	104.00	76.512	141.36	***
Other	2.73	3.144	23.19	16.392	32.82	***

Notes:

1 – Model C-Statistic 0.87

2 – p-value:

* - $p < 0.05$

** - $p < 0.01$

*** - $p < 0.001$

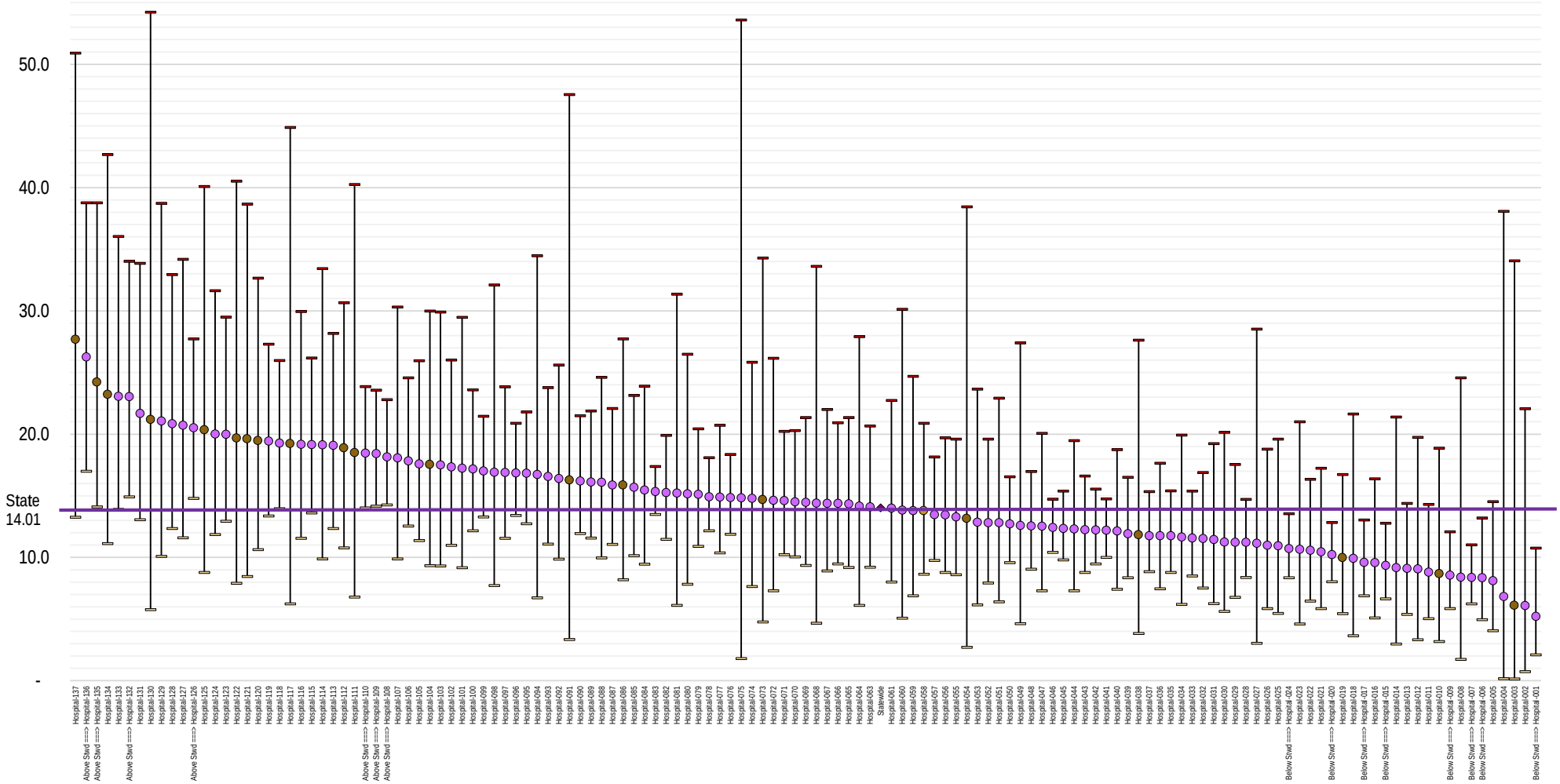
3 - APR-021-1- Craniotomy Except For Trauma – All Patient Refined Diagnosis Related Groups is a product of the 3M Grouper. APR DRG were assigned with taking into account present on admission indicator (POA). Last numbers before the description (-1-) are risk of mortality (ROM), combined or separate.

Table 5. Comparison of Stroke RAMR by Stroke Designation Status, SPARCS, 2013

Stroke Designation	Hospitals, N	Discharges, N	Died, N	Ratio[1]	RAMR[2]	95th Lower CI[3]	95th Upper CI[3]	Bottom Performing Hospitals[4], N	Top Performing Hospitals[4], N
All Hospitals									
No	68	1,831	293	1.29	18.10	16.08	20.29	4	0
Yes	116	26,312	3,650	0.98	13.76	13.32	14.21	6	8
Total, All	184	28,143	3,943		14.01			10	8
Hospitals with 30+ Stroke Discharges									
No	21	1,367	189	1.17	16.41	14.15	18.92	1	0
Yes	115	26,287	3,646	0.98	13.76	13.32	14.21	6	8
Total, 30+	136	27,654	3,835					7	8

Notes:
1 – Ratio of OMR/EMR.
2 – RAMR – risk adjusted mortality rate, per 100 stroke admissions.
3 – 95th percentiles, upper and lower bounds for the confidence intervals.
4 – Number of hospitals above or below (95% CI) statewide observed mortality rate (14.01).

Figure 1. In-Hospital/30-Day Mortality Post Stroke Admission, Risk Adjusted Rates by Facility, SPARCS, 2013



Notes:

1. Only facilities with 30 or more stroke cases in CY 2013 are represented (N=136).
2. Purple (lighter) circles – Stroke Designated Centers. Blue (darker) circles – not Stroke Designated Centers.
3. Diamond and a reference line represent statewide average stroke mortality rate (14.01); tick marks correspond to upper and lower 95th percentiles for the facility-level RAMR for stroke discharges.

References

1. NYS Vital Statistics. Available at: https://www.health.ny.gov/statistics/leadingcauses_death/deaths_by_county.htm

2. Alberts, M.J, et al., Revised and Updated Recommendations for the Establishment of Primary Stroke Centers. A Summary Statement from the Brain Attack Coalition Brain Attack Coalition Guidelines. Stroke, 2011. **42**: p. 2651-2665. Available at: https://www.brainattackcoalition.org/#BAC_Publications

3. Inpatient Quality Indicators (IQI) #17, Technical Specifications, Acute Stroke Mortality Rate. Agency for Health Care Research and Quality, AHRQ QI™ Version 4.5. 2014; Available from: http://www.qualityindicators.ahrq.gov/Downloads/Modules/IQI/V45/TechSpecs/IQI%2017%20Acute%20Stroke%20Mortality%20Rate.pdf

4. Krumholz, H.M., et al., Standards for statistical models used for public reporting of health outcomes: an American Heart Association Scientific Statement from the Quality of Care and Outcomes Research Interdisciplinary Writing Group: cosponsored by the Council on Epidemiology and Prevention and the Stroke Council. Endorsed by the American College of Cardiology Foundation. Circulation, 2006. **113**(3): p. 456-62.

5. AHRQ Quality Indicators. Inpatient Quality Indicators (IQI) Parameter Estimates. Version 4.5. 2014 [cited 2014; Available from: http://www.qualityindicators.ahrq.gov/Downloads/Modules/IQI/V45/Parameter_Estimates_IQI_45.pdf

6. Steyerberg, E.W., et al., Assessing the performance of prediction models: a framework for traditional and novel measures. Epidemiology, 2010. **21**(1): p. 128-38.

7. 3M™ Grouper, v.31. 2014; Available from: http://solutions.3m.com/wps/portal/3M/en_US/Health-Information-Systems/HIS/Products-and-Services/Products-List-A-Z/Grouper-Plus-System/

8. Elixhauser, A., et al., Comorbidity measures for use with administrative data. Med Care, 1998. **36**(1): p. 8-27.

9. Fay, M.P. and E.J. Feuer, Confidence intervals for directly standardized rates: a method based on the gamma distribution. Stat Med, 1997. **16**(7): p. 791-801.

10. All Payer In-Hospital/30-Day Acute Stroke Mortality Rates by Hospital (SPARCS): Beginning 2013; Available at: https://health.data.ny.gov/Health/All-Payer-In-Hospital-30-Day-Acute-Stroke-Mortalit/r29i-yr49

11. NYS Health Profiles, Hospital-specific mortality rates. Stroke statistics will be available in CY 2016 at: http://profiles.health.ny.gov/hospital/view/103004#quality

Definitions

- Stroke: Stroke is a medical emergency that occurs when a blood vessel either bursts or becomes blocked by fatty substances or a blood clot, interrupting blood flow to the brain. Without immediate treatment, cells in the brain begin to die, resulting in brain damage, paralysis, or even death. Warning signs and the necessary response are face drooping; arm or leg weakness or numbness; speech difficulty; time to call 9-1-1, or F.A.S.T (American Heart Association/American Stroke Association).

- SPARCS: The Statewide Planning and Research Cooperative System (SPARCS) is a comprehensive data reporting system established in 1979 as a result of cooperation between the health care industry and government. Initially created to collect information on discharges from hospitals, SPARCS currently collects patient level detail on patient characteristics, diagnoses and treatments, services, and charges for every Article 28 (acute care) hospital discharge, ambulatory surgery, emergency room visits, and visits to hospital-based outpatient clinics in New York State. More information on SPARCS may be found at the following direct link: http://www.health.ny.gov/statistics/sparcs/

- AHRQ: The Agency for Healthcare Research and Quality (AHRQ) was originally created as the Agency for Health Care Policy and Research (AHCPR) on December 19, 1989, under the Omnibus Budget Reconciliation Act of 1989, as a Public Health Service Agency in the U.S. Department of Health and Human Services (HHS). The Agency was reauthorized with a name change as the Agency for Healthcare Research and Quality on December 6, 1999, under the Healthcare Research and Quality Act of 1999. The AHRQ mission is to produce evidence to make health care safer, higher quality, more accessible, equitable, and affordable, and to work within the U.S. Department of Health and Human Services and with other partners to make sure that the evidence is understood and used. For more information follow the direct link: http://www.qualityindicators.ahrq.gov/modules/psi_resources.aspx

- HCUP: The Healthcare Cost and Utilization Project (HCUP) includes the largest collection of longitudinal hospital care data in the United States. Sponsored by AHRQ, HCUP includes the largest all payer encounter level health care data (inpatient, emergency department and ambulatory surgery records) in the U.S., beginning in 1988. HCUP is a Federal-State-Industry partnership that brings together data collection efforts of many organizations to create a national health care information resource. For more information follow the direct link: http://www.hcup-us.ahrq.gov/

- Unit of Analysis: The unit of analysis for this report is the hospital inpatient discharge, not the patient.

- Physician Advisory Workgroup: A select group of neurologists and emergency medicine physicians throughout the state that meet on a regular basis to make recommendations to the Commissioner.

- Heath Data NY is a New York State Department of Health sponsored data site that provides health care providers, researchers, academics, and the general public with access to valuable health data. The data site allows users to download and analyze data in a variety of formats, create visualizations of the data and review metadata and can be accessed at https://health.data.ny.gov.

- Present on Admission (POA) is an indicator associated with each diagnosis. It specifies whether the onset of the diagnosis preceded or followed admission to the hospital. As part of the SPARCS reporting, all NYS hospitals must submit POA information on the principal and all secondary diagnoses for all inpatient discharges. For additional details please use link: http://www.health.ny.gov/statistics/sparcs/sysdoc/inpatientoutputdd.pdf

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