Emerging Challenges for Stroke Outcomes Evaluation: A Public Health Agency Perspective

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Background

- Several states have designated their hospitals as stroke centers to help improve quality of stroke care
  - This suggests evaluation of patient outcomes for one or more measures
- Important leadership provided by the Centers for Disease Control and Prevention (CDC), American Heart/American Stroke Association (AHA/ASA) and The Joint Commission (JC)
- Key role played by the Brain Attack Coalition through two papers outlining guidelines for stroke centers
  - Primary stroke centers (Alberts, Hademenos, Latchaw, et. al., 2000)
  - Comprehensive stroke centers (Alberts, Latchaw, Selman, et. al., 2005)

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The New Jersey Acute Stroke Registry

- The New Jersey Acute Stroke Registry (NJASR) was launched in 2010 to facilitate "outcome and quality" assessment
  - NJASR was preceded by a 2004 statute, the Stroke Centers Act (P.L.1971, c.136 (C.26:2H-1 et seq.)
  - Currently 64 designated acute care hospitals out of 72
    - 12 comprehensive, 52 primary
- Data Collection Launched on January 1, 2010

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Objectives

- Provide evidence that stroke consensus measures have limitations as performance assessment measures by public health (state) agencies
- Suggest an alternative and sustainable approach to using consensus measures
  - Provide a statistical approach that corrects for the two shortcomings of the consensus measures
    - By adjusting (controlling) for patient mix such as pre-existing health conditions of the patient, age, gender, race/ethnicity, and other current clinical factors

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Designated Stroke Centers in New Jersey

Updated: October, 2011 Source: The Office of Health Care Quality Assessment, NJDHSS

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Brief Description of Data Used

Figure 1. Race/Ethnic Distribution, NJASR 2010

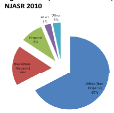
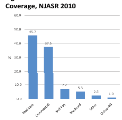


Figure 2. Health Insurance Coverage, NJASR 2010



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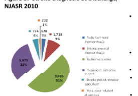
Brief Description of Data Used (Cont.)

Figure 3. Stroke Diagnosis at Discharge, NJASR 2010



Brief Overview of Data

- 19,539 patients reported to NJASR in 2010
  - 51% ischemic stroke, 12% hemorrhagic stroke, 32% Transient Ischemic Attack (TIA) patients
- Two-thirds of stroke patients were at least 65 years old
- 45% were female
- 67% were white, 18% black, 9% Hispanic
- 50% of patients arrived by EMS
- 38% had private (commercial) health insurance while 46% had Medicare coverage

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Figure 4. Statewide Level of Consensus Measures

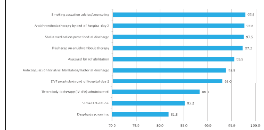

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Table 1. Variation of Consensus Measures by Hospitals, New Jersey 2010

	Consensus Measure	Statewide (%)	Hospitals				
			# Facilities	Mean (%)	Median (p50)	Coef. of Var. (cv)	Topped-Out (Yes/No)
1	DVT prophylaxis end of hospital day 2	93.0	61	91	95	11.4	No
2	Assessed for rehabilitation	95.5	61	93	95	9	Yes
3	Discharge on antithrombotic therapy	97.2	61	97	98	4.4	Yes
4	Anticoagulation for atrial fibrillation/flutter at discharge	93.8	61	90	95	18.1	No
5	Thrombolytic therapy (IV tPA) administered	88.[illegible]	56	83	97	33.4	No
6	Antithrombotic therapy by end of hospital day 2	97.6	61	98	99	2.4	Yes
7	Statin medication prescribed at discharge	97.5	61	97	98	3.2	Yes
8	Dysphagia screening	81.8	61	77	81	22.9	No
9	Stroke Education	85.2	61	79	85	27.5	No
10	Smoking cessation advice/counseling	97.8	60	97	100	7.4	Yes

*A measure is considered to have topped-out if p95-p75 < 2*SD AND the truncated coefficient of variation (i.e., cv for p5 to p95) < 10% (Dale Bratzler, CMS)

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Results

- Statewide consensus measures are high and will increasingly get closer to 100% soon
- Hospital variations are limited where 5 of the 10 consensus measures have already topped-out
- There is a need for alternative means to assess hospital performance that does not depend on consensus measures

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Methods

- Stepwise logistic regression models fitted to:
  - Ischemic Stroke mortality
  - Ischemic Stroke Outcome
    - Modified ranking scale:
      - 0-2 = favorable outcome, 3-6 = unfavorable outcome
  - Selection criteria for parameters was $\alpha = 0.05$
- Predictors Used
  - Several pre-existing health condition
  - Socio-demographic factors
    - Age, gender, race/ethnicity, health insurance status,…

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Form of Fitted Logistic Regression Model

- The fitted logistic regression models are of the following form where the "logit" of the probability of dying (or unfavorable outcome) for patient i (p_i), is denoted by Y_i:

$$Y_i = \sum_k^K \beta_k X_{ki} + \varepsilon_i$$

Where,
$X_{0i} = 1$
i = 1, 2, …, n; k = 0,1,2,…,k,
β_k = Logistic regression coefficient for risk factor X_k,
K = Number of risk factors in the model,
n = Number of patients,
ε_i = Random error term i.

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Estimation of Expected Mortality

- Logistic regression parameter estimates used to predict individual probabilities of:
  - dying from ischemic stroke following hospital encounter
    - aggregate individual probabilities to obtain number of expected deaths in each hospital
  - unfavorable outcomes (Outcome, i.e., severe disability or death) following hospital encounter
    - aggregate individual probabilities to obtain number of expected unfavorable outcomes in each hospital
- Calculate risk-adjusted rates as the ratio of observed to expected mortality (or outcome) as a factor of the statewide rate

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Mathematical Expression For predicting Probabilities

- Using statistical notations, the predicted probability of dying (or outcome) for patient i ($\hat{p}_i$) is given as follows:

$$\hat{p}_i = \frac{e^{\hat{Y}_i}}{1+e^{\hat{Y}_i}}, \text{ Where } i = 1,2,3,\ldots,n$$

Where, $\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_{1i} + \hat{\beta}_2 X_{2i} + \hat{\beta}_3 X_{3i} + \ldots + \hat{\beta}_k X_{ki}$

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Modeling Results

- Stroke mortality model associated with limited number of risk factors for comfort (Table 2)
- Outcome model identified a reasonable mix of risk factors and has a slightly better predictive power (Table 3)
- Hemorrhagic stroke mortality (outcome) models show similar patterns

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Table 2. Parameter Estimates Obtained from Fitting Ischemic in-hospital Deaths on Risk Factors

Risk Factor	Parameter Estimate	Odds Ratio Estimate	Std. Error	Wald Chi-Square	Pr > ChiSq
Intercept	-3.713		0.144	662.7	<.0001
Demographics					
Place of Occurrence: 1 = Home, 0 Other	0.316	1.372	0.138	5.2	0.0221
Age 65+	0.403	1.497	0.141	8.1	0.0043
Being Underweight (BMI < 18.5)	0.524	1.688	0.167	9.8	0.0017
Facility Designation : 1 = Primary, 0 = Comprehensive	-0.622	0.537	0.104	35.5	<.0001
Arrival Mode: 1= EMS arrival, 0=Other	0.664	1.943	0.116	33.1	<.0001
Medical History					
[illegible] (CAD)	0.243	1.275	0.118	4.3	0.0392
Cholesterol medication prior to hospitalization	-0.334	0.716	0.112	9.0	0.0028
Documented medical history of atrial fibrillation/flutter	0.544	1.723	0.116	21.8	<.0001
Able to ambulate independently	0.366	1.441	0.133	7.5	0.0061

C-statistic = .701, n = 9,211

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Table 3. Parameter Estimates Obtained by Fitting a Logistic Regression Model on Outcome Variable (Outcome = Modified Ranking Scale of 3 or higher, includes deaths)

Risk Factor	Parameter Estimate	Odds Ratio	Std. Error	Wald Chi-Square	Pr > ChiSq
Intercept	-1.751		0.075	550.748	<.0001
Demographics					
Place of Occurrence: 1 = Home, 0 Other	1.064	2.896	0.073	215.319	<.0001
Age 65+	0.583	1.791	0.059	96.407	<.0001
Gender: 0 = Male, 1= Female	-0.191	0.826	0.049	15.222	<.0001
Race/Ethnicity: Hispanic or Latino Origin	-0.284	0.752	0.090	9.967	0.0016
Arrival Mode: 0=Other arrival mode, 1= EMS arrival	0.795	2.214	0.049	260.339	<.0001
Facility Designation: 1 = Primary, 0 = Comprehensive	0.171	1.186	0.049	12.247	0.0005
Body Mass Index					
Underweight (BMI < 18.5)	0.220	1.246	0.097	5.100	0.0239
Obese (BMI >= 30)	-0.137	0.872	0.055	6.188	0.0129
Medical History					
Prior Stroke/Transient ischemic Attack/VBI	0.157	1.169	0.054	8.272	0.004
Heart failure	0.386	1.470	0.095	16.372	<.0001
Myocardial infarction (MI) or coronary artery disease (CAD)	0.172	1.188	0.059	8.619	0.0033
Peripheral arterial disease (PAD)	0.517	1.677	0.132	15.446	<.0001
Medical history of Dyslipidemia	0.134	1.143	0.060	5.040	0.0248
Cholesterol medication prior to hospitalization	-0.240	0.787	0.062	14.857	0.0001
Taking antithrombotic medication prior to admission	-0.202	0.817	0.055	13.543	0.0002
Documented medical history of atrial fibrillation/flutter	0.313	1.367	0.088	12.709	0.0004
Able to ambulate independently	0.810	2.248	0.069	137.224	<.0001
AFIB or paroxysmal atrial fibrillation (PAF), during current episode of care	0.273	1.314	0.080	11.638	0.0006

C-statistic = .742, n = 9,211

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Figure 5. Risk-adjusted Ischemic Stroke Mortality by Hospital, NJASR 2010

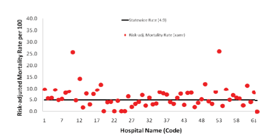

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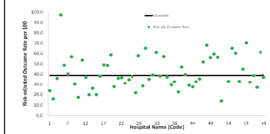
Figure 6. Risk-adjusted Ischemic Stroke Outcome by Hospital, NJASR 2010



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Conclusions/implications for Practice

- Only a handful of patient characteristics predict in-hospital mortality even though mortality is the most reliable indicator in most other type of registries.
  - The handful of risk factors do not provide enough comfort level to be used in assessing hospital performance by public health agencies
  - No compelling reason to use mortality as the sole outcome measure in a complex disease such as ischemic stroke.
- Using the modified ranking scale as an alternative outcome appears to present a better predictive power
  - Has a lot more risk factors emerging as significant predictors for outcome than was obtained from using ischemic stroke mortality alone
- Stroke consensus measures as performance indicators are likely to fall out of favor in the next few years in states that are currently designating stroke centers.
  - With CMS requiring stroke data collection and The Joint Commission continuing to certify primary (and possibly comprehensive) stroke centers, the importance of these consensus measures as assessment tools may decline even faster than one expects.
- Public health agencies should be attentive to the purposes registries are to be used for before committing to projects to make sure so that the registries meet the intended performance evaluation goals.

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