Is stroke mortality a reasonable measure of stroke care quality?

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Disclosures

- I have no financial interest in any commercial products or services related to this talk
- I will not discuss off-label indications for medications or devices
- However, all researchers (including me) are influenced by their personal views and the alignment between those views and their funding sources (e.g., AHRQ Support for Quality Indicators contract 290-04-0020)

Is stroke mortality a reasonable measure of stroke care quality?

- What is a “reasonable measure”?
  - In the eye of the beholder…
- What is “care quality”?

What is quality?

- **Institute of Medicine (1990):**

  "Quality of care is the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge."
- **Brook and McGlynn (1991):**

  "High quality care…produces positive changes, or slows the decline, in health; low quality care fails to prevent or accelerates a decline in a person's health."
- **Pauly (2004):**

  "anything and everything about some good or service relevant to consumers' (actual and perceived) well-being that is not measured by quantity" (or price).

IOM Domains of Quality

Effectiveness

- Providing services based on scientific knowledge (avoiding overuse of inappropriate care, underuse of appropriate care)

Patient Centeredness

- Respectful of and responsive to patient preferences, needs, values

Timeliness

- Reducing wait times and sometimes harmful delays

Safety

- Avoiding injuries to patients…

Efficiency

- Avoiding waste of equipment, supplies, ideas, and energy

Equity

- Care does not vary in quality because of personal characteristics

In search of a balanced set of quality measures: Institute of Medicine, 2010

Crosscutting Dimensions

EQUITY

VALUE

Components of Quality Care	Type of Care		
	Preventive Care	Acute Treatment	Chronic condition management
Effectiveness			
Safety			
Timeliness			
Patient/family-centeredness			
Access			
Efficiency			
Care Coordination			
Health Systems Infrastructure Capabilities			

National Quality Strategy (HHS) Six priorities

- Making care safer by reducing harm…
- Ensuring that each person and family are engaged as partners in their care.
- Promoting effective communication and coordination of care.
- Promoting the most effective prevention and treatment practices for the leading causes of mortality, starting with cardiovascular disease.
- Working with communities to promote wide use of best practices to enable healthy living.
- Making quality care more affordable for individuals, families, employers, and governments by developing and spreading new health care delivery models.

What is a “reasonable measure”? NQF Measure Evaluation Criteria

- Importance to measure and report
  - High impact
  - Performance gap
  - Evidence to support the measure focus
- Scientific acceptability of measure properties
  - Reliability
  - Validity
- Usability
  - Meaningful, understandable and useful to intended audiences for public reporting and QI
- Feasibility

High impact

- Stroke accounted for 1 of every 18 deaths in the US in 2007.
- About 795,000 strokes occur annually in the US
- 135,952 stroke deaths in 2007 (#3 or #4 cause)
- 46% of stroke deaths in 2007 occurred in the hospital
- Among people 45 to 64 years of age, 8% to 12% of ischemic strokes and 37% to 38% of hemorrhagic strokes result in death within 30 days
- Among people 65+ years of age recruited from Part B eligibility lists, 30-day case fatality was 8.1% for ischemic strokes and 44.6% for hemorrhagic strokes.
- Between 50% and 70% of stroke survivors regain functional independence, but 15% to 30% are permanently disabled, and 20% require institutional care at 3 months after onset
- Estimated direct medical cost was $25.2 billion in 2007
- Mean lifetime cost of ischemic stroke estimated at $140,048

Performance gap

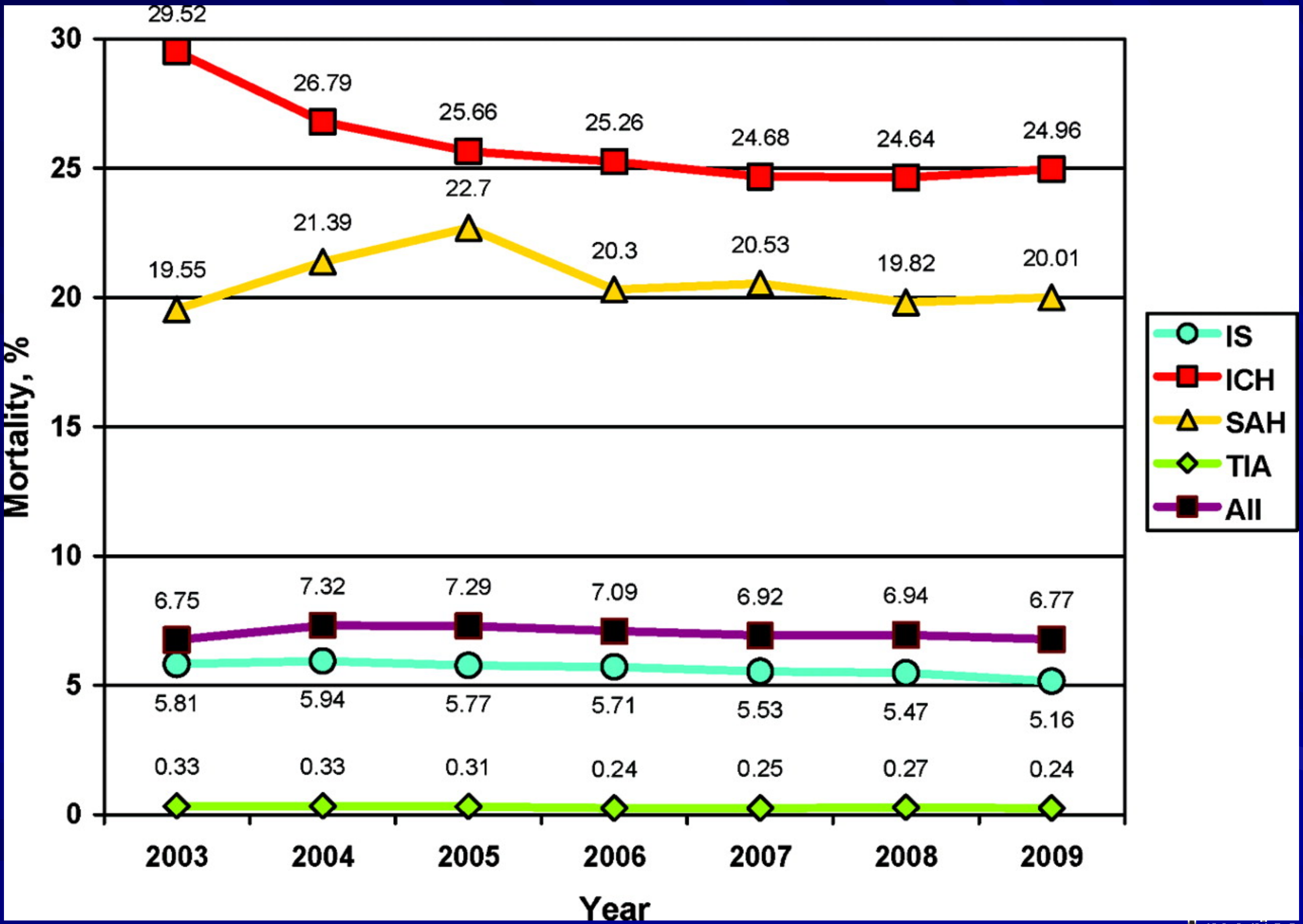
Table 2. Hospital-Level Clinical Outcomes in Ischemic Stroke, Risk-Adjusted

Outcomes, Adjusted	Event Rates Mean±SD	Distribution of Hospital Event Rates				
		10th	25th	Median	75th	90th
Death						
In-hospital	5.7±2.2%	2.8%	4.6%	6.0%	6.9%	8.2%
30-day (admission to 30 days†)	13.9±3.5%	9.8%	12.1%	14.2%	15.6%	17.8%
90-day (admission to 90 days†)	20.1±4.2%	15.3%	18.2%	20.2%	22.2%	25.1%
1-year (admission to 1 year†)	30.9±4.6%	25.2%	28.6%	31.0%	33.0%	36.3%
Death (among hospital survivors)						
30-day (discharge to 30 days‡)	9.5±3.2%	5.7%	7.9%	9.6%	11.0%	13.2%
90-day (discharge to 90 days‡)	15.2±3.9%	10.6%	13.3%	15.3%	17.0%	19.6%
1-year (discharge to 1 year‡)	26.2±4.5%	20.7%	24.0%	26.2%	28.4%	31.3%
Rehospitalization						
30-day (discharge to 30 days‡)	14.1±4.2%	9.1%	12.0%	14.3%	16.1%	19.0%
90-day (discharge to 90 days‡)	29.2±5.3%	23.0%	26.6%	29.4%	31.8%	35.3%
1-year (discharge to 1 year‡)	55.3±5.5%	48.5%	52.2%	55.5%	58.4%	62.0%
Death or rehospitalization (among hospital survivors)						
30-day (discharge to 30 days‡)	21.1±4.8%	15.8%	19.0%	21.4%	23.4%	26.3%
90-day (discharge to 90 days‡)	36.8±5.3%	30.7%	34.4%	37.2%	39.4%	43.2%
1-year (discharge to 1 year‡)	61.7±5.2%	55.8%	58.9%	61.7%	64.3%	67.7%

Adjusted for patient characteristics: age, sex, minority (yes/no); on-hour arrival time (yes/no); emergency medical services transport (yes/no); and medical histories (including atrial fibrillation, previous stroke/transient ischemic attack, coronary artery disease/prior myocardial infarction, carotid stenosis, diabetes mellitus, peripheral vascular disease, hypertension, smoking, and dyslipidemia). Hospital effect is fitted as a random intercept in the generalized mixed effect models. C-statistics for the models are as follows: death rates in 30 days after admission 0.70, death rate in 1 year after discharge 0.71, rehospitalization in 30 days after discharge 0.59, rehospitalization rates in 1 year after discharge 0.62, death or rehospitalization rate in 30 days after discharge 0.70, death or rehospitalization in 1 year after discharge 0.64. Reported risk-adjusted hospital level outcome rates are calculated as observed/expected.

Fonarow G, et al. Stroke 2011;42(1):159-66.

Temporal trends in acute stroke and TIA in-hospital mortality 2003 to 2009.



Fonarow GC et al. Circ Cardiovasc Qual Outcomes 2010;3:291-302

American Heart Association
Learn and Live

Evidence to support measure focus

- RCTs of thrombolysis for ischemic stroke
- Meta-analyses and observational studies suggesting importance of protocol adherence
- RCTs of thromboembolism prophylaxis
- RCTs of dedicated stroke units
- Observational data re glycemic control
- Observational data re BP control

Future evidence?

- Statin therapy at presentation?
- Dysphagia evaluation?
- Head positioning?
- Fever management?
- Endovascular interventions?

Reliability

- Systematic provider-level standard deviation = 5.3%
- Systematic provider variation = 1.7% of total variation
- Signal ratio (provider signal:noise) = 52%

Validity

- Criterion validity based on multiple studies showing 85-100% sensitivity and PPV in identifying acute strokes using ICD-9-CM or ICD-10 coded data
- Construct validity based on studies of hospital characteristics
  - Hospital volume, teaching status
  - Stroke center status
  - Hospitals with dedicated stroke service

Risk-adjusted stroke mortality (IQI 17)

	Rate per 1000	Std error	P value
Large central metro	86.173	0.577	0.524
Large fringe metro	85.541	0.807	
Medium metro	91.364	0.770	0.000
Small metro	101.496	1.068	0.000
Micropolitan	115.556	1.453	0.000
Rural	138.733	2.599	0.000
Teaching	88.794	0.564	0.000
Nonteaching	94.316	0.468	
Less than 100	120.598	1.425	0.000
100 - 299	91.339	0.636	
300 - 499	89.867	0.610	0.095
500 or more	88.212	0.695	0.001

“Straw man” arguments against usability

- Different risk-adjusted mortality measures generate different results
- Risk-adjusted mortality data can be misused (unintended consequences)
- Other outcomes are more important than survival/death
- Shouldn’t mix different types of strokes

Different risk-adjusted mortality measures generate different results

Table 3

New York State Hospital Inpatient Mortality Ratings Using Two Different Report Cards

		Niagara Coalition			
		Below average	**Average**	**Above average**	**Total**
HealthGrades	Below average	11	44	1	56
	Average	5	84	8	97
	Above Average	0	3	1	4
	Total	16	131	10	157

Kelly A, et al. Stroke 2008;39:3367-71.

But the same is true of every condition…

Table 3.—Statistical Performance of Severity Measures*

Severity Measures	Acute Myocardial Infarction c (95% CI)	Acute Myocardial Infarction R^2 (95% CI)	Coronary Artery Bypass Graft c (95% CI)	Coronary Artery Bypass Graft R^2 (95% CI)	Pneumonia c (95% CI)	Pneumonia R^2 (95% CI)	Stroke c (95% CI)	Stroke R^2 (95% CI)
MedisGroups	0.83 (.83-.85)	22.7 (21.1-24.7)	0.73 (.70-.76)	3.6 (2.4-5.4)	0.85 (.85-.86)	19.0 (17.9-21.0)	0.87 (.86-.88)	26.5 (24.3-29.1)
Physiology score	0.83 (.82-.84)	22.9 (21.0-24.8)	0.72 (.70-.76)	2.8 (1.7-5.3)	0.81 (.81-.83)	14.9 (14.0-16.7)	0.84 (.83-.85)	24.2 (21.8-26.7)
Disease Staging	0.86 (.85-.87)	27.0 (24.8-28.9)	0.77 (.74-.80)	6.9 (4.3-9.8)	0.80 (.80-.82)	13.2 (12.5-14.8)	0.74 (.73-.76)	11.2 (9.2-13.3)
PMC Severity Scale	0.82 (.81-.83)	17.6 (16.3-19.4)	0.80 (.78-.83)	7.9 (5.9-11.1)	0.79 (.79-.80)	11.5 (11.0-12.8)	0.73 (.72-.75)	10.1 (8.6-11.8)
APR-DRGs	0.84 (.83-.85)	19.8 (18.4-21.4)	0.83 (.81-.86)	6.6 (5.5-8.3)	0.78 (.78-.80)	10.1 (9.9-12.0)	0.77 (.75-.78)	10.5 (9.0-12.6)

*Conditions and statistical performance measures, c and $R^2 \times 100$. CI indicates confidence interval. See footnote in Table 1 for expansion of severity measure abbreviations.

- C=0.867 for current model that includes age, sex, APR-DRGs and Risk of Mortality subclasses

Iezzoni L. JAMA 1997;278:1600-7.

But the same is true of every condition…

Severity Measures (Including Unadjusted Mortality Rates)	Conditions and No. of Hospitals in Best and Worst 10%							
	Acute Myocardial Infarction† (n=10)		Coronary Artery Bypass Graft‡ (n=4)		Pneumonia§ (n=11)		Stroke‖ (n=9)	
	Best	Worst	Best	Worst	Best	Worst	Best	Worst
MedisGroups								
Physiology score	9	10	4	4	6	8	7	6
Disease Staging	6	3	2	3	5	5	5	3
PMC Severity Scale	7	5	2	2	6	8	4	3
APR-DRGs	6	4	1	2	6	7	6	4
Unadjusted rates	5	6	3	4	3	6	3	5
Physiology score								
Disease Staging	5	3	2	3	4	7	5	3
PMC Severity Scale	6	5	2	2	7	9	6	3
APR-DRGs	6	4	1	2	5	8	6	3
Unadjusted rates	6	6	3	4	3	9	5	5
Disease Staging								
PMC Severity Scale	7	5	3	2	4	7	6	3
APR-DRGs	7	5	2	2	4	6	7	3
Unadjusted rates	5	4	1	3	1	7	5	3
PMC Severity Scale								
APR-DRGs	8	9	2	2	7	10	7	7
Unadjusted rates	4	6	1	2	5	7	7	6
APR-DRGs								
Unadjusted rates	6	6	1	2	5	7	6	5

*See footnote in Table 1 for expansion of severity measure abbreviations.

†Number of hospitals on which pairs of severity measures agreed and associated κ value: 3, κ=0.22; 4, κ=0.33; 5, κ=0.44; 6, κ=0.56; 7, κ=0.67; 8, κ=0.78; 9, κ=0.89; and 10, κ=1.00.

‡Because of small number of hospitals, κ values were unreliable.

§Number of hospitals on which pairs of severity measures agreed and associated κ: 5, κ=0.39; 6, κ=0.49; 7, κ=0.59; 8, κ=0.70; 9, κ=0.80; and 10, κ=0.90.

‖Number of hospitals on which pairs of severity measures agreed and associated κ: 3, κ=0.26; 4, κ=0.39; 5, κ=0.51; 6, κ=0.63; and 7, κ=0.75.

Iezzoni L. JAMA 1997;278:1600-7.

May the best measure win…

Table 1. Related versus Competing Measures

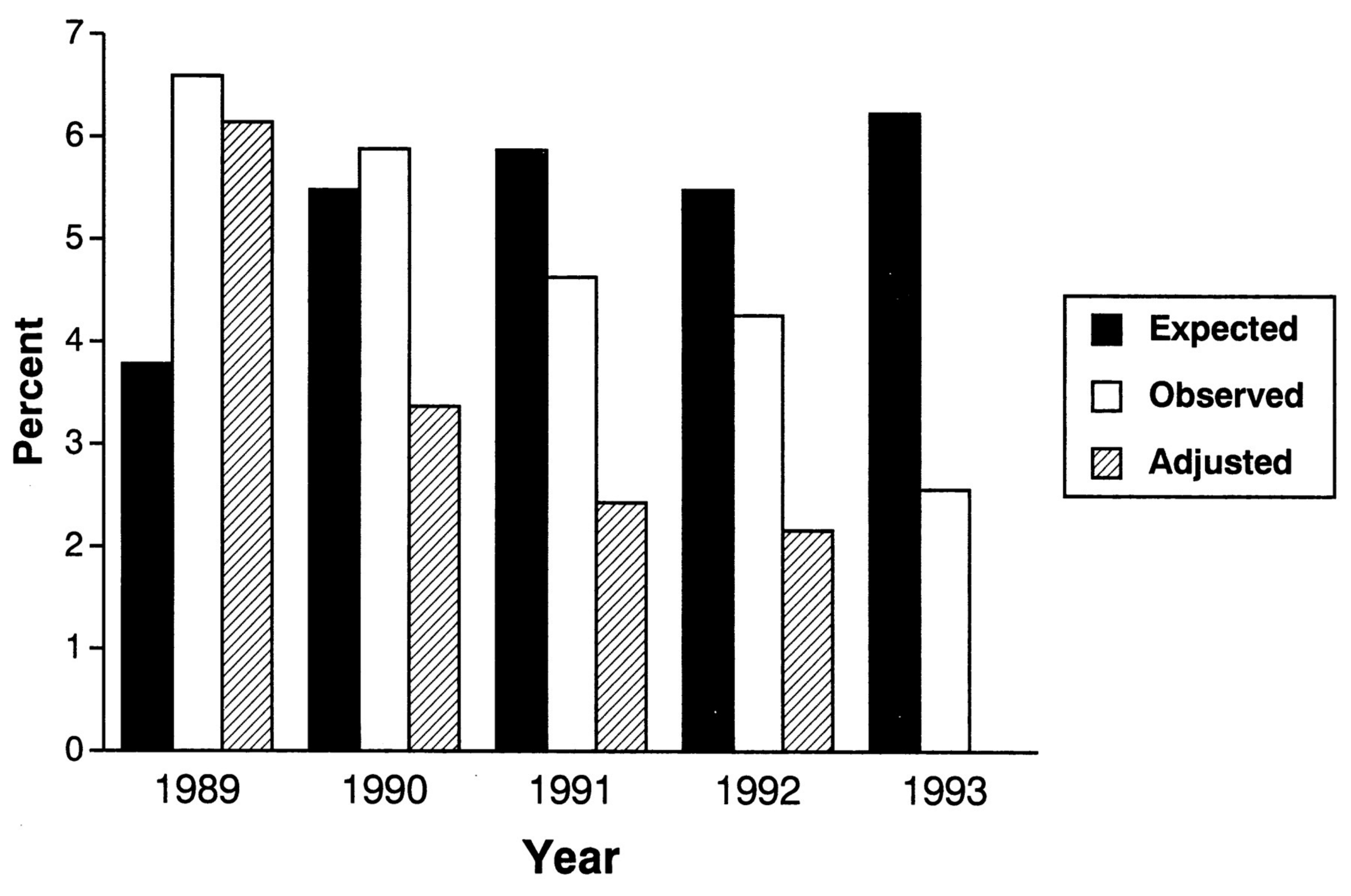
	Same measure focus—target process, condition, event, outcome (numerator)	**Different measure focus—target process, condition, event, outcome** (numerator)
Same target population (denominator)	**Competing measures**—Select best measure from competing measures or justify endorsement of additional measure(s).	**Related measures—Harmonize** on target population or justify differences.
Different target population (denominator)	**Related measures—Harmonize** on measure focus or justify differences; or possibly combine into one measure with expanded target population.	Neither harmonization nor competing measure issue

NQF Guidance for Measure Harmonization, December 2010.

Risk-adjusted mortality data can be misused

- So what can't be misused?
- Paternalism is not an acceptable justification for withholding information
  - Justice Hughes, ruling in Newsday, Inc. v. NYS Dept of Health (Sup. Ct. Albany 1991), noted that if the Health Department's argument was extended, it "[would] appear that if members of the public were more intelligent, it would [then] be in the public interest to disclose this information. The duty of administrators to release to the population records of its government cannot be dependent upon the administrators' assessment of the population's intelligence."
- Sorting of high-risk patients is generally desirable, not "misuse"
- Two legitimate concerns with empirical support:
  - Potential to increase disparities in both selection and outcomes
  - Potential to shift setting of death instead of preventing deaths

Expected, observed, and risk-adjusted mortality rates of New York referrals to the Cleveland Clinic, 1989 through 1993

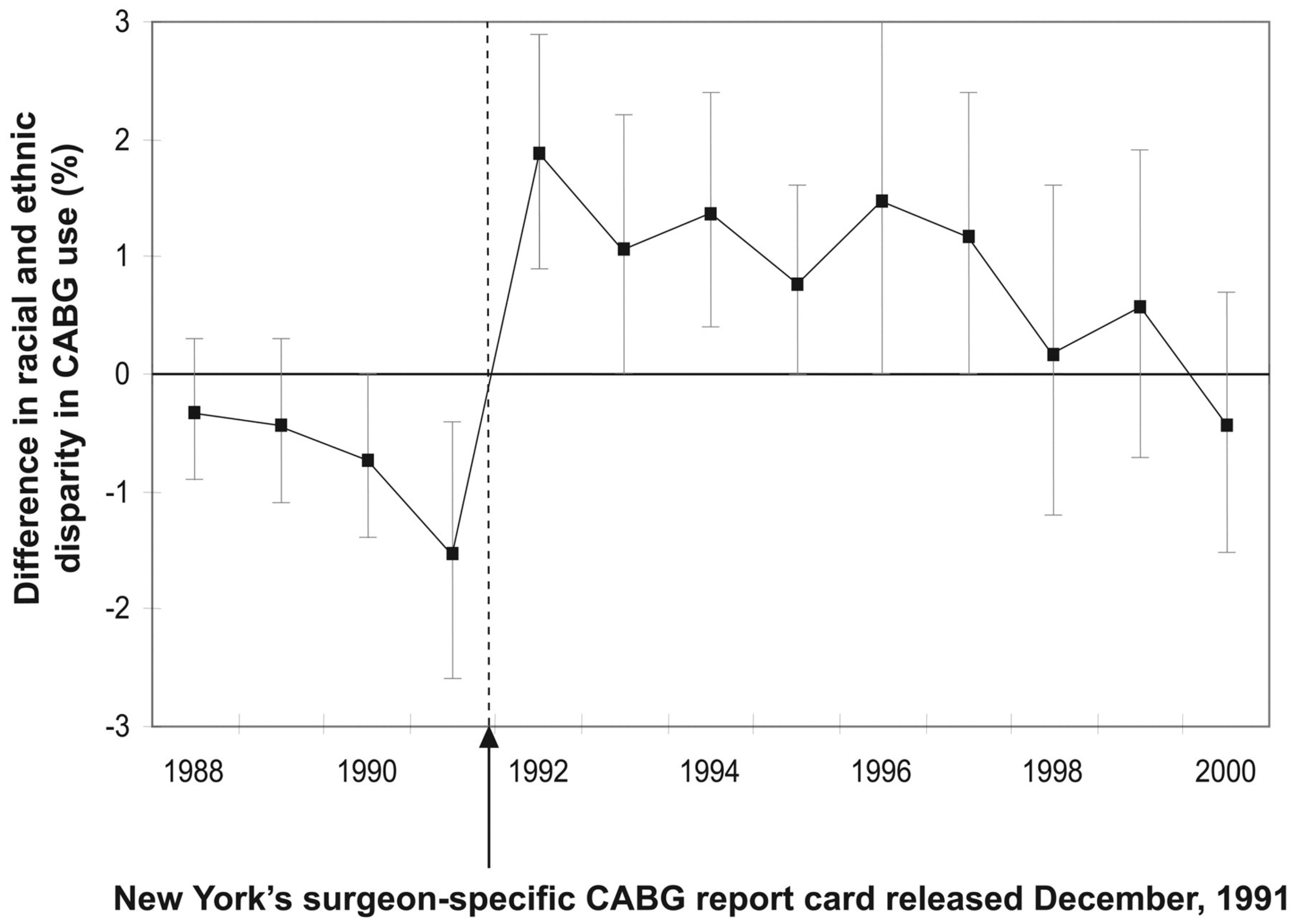


Omoigui, N. A. et al. Circulation 1996;93:27-33

Counter-arguments

- Only 482 patients left NY for the Cleveland Clinic, versus 73,877 who stayed in NY
- The total percentage of patients leaving NY for CABG actually declined (12.5-14.3% to 11.3%)
- The percentage of high-risk patients undergoing CABG in NY increased by 73%
- Risk-adjustment adequately accounts for additional risk sorting (although surgeons may be skeptical, and may still discriminate)
- BUT even if undesirable selection can be avoided, population disparities in outcomes may increase due to variation in how information is used

Annual differences of percentage of patients with AMI undergoing CABG between New York and comparison states (adjusted for age, gender, median income by ZIP code, insurance, percent of black and Hispanic patients admitted annually with AMI at each hospital, and severity of illness)



Werner, R. M. et al. Circulation 2005;111:1257-1263

The real problem is shifting deaths to other settings of care (superiority of time-defined outcomes)

TABLE 4. Absolute Change (95% CI) and Relative Change (%, 95% CI) in Adjusted In-Hospital, 30-Day, and Early Postdischarge Mortality Rates Between 1991 and 1997 for Medicare Patients Hospitalized in Northeast Ohio With a Principal Discharge Diagnosis of Acute Myocardial Infarction (AMI), Congestive Heart Failure (CHF), Gastrointestinal Hemorrhage (GIH), Chronic Obstructive Pulmonary Disease (COPD), Pneumonia (PNEU), and Stroke (STR)

	AMI	CHF	GIH	COPD	PNEU	STR
In-Hospital Mortality						
Absolute change	−4.1 (−6.4, −1.5)†	−3.7 (−4.3, −3.0)‡	−2.7 (−3.6, −1.4)‡	−2.1 (−2.8, −1.3)‡	−4.8 (−5.9, −3.7)‡	−1.0 (−2.6, 0.9)
Relative change	−22.4 (−34.6, −8.4)	−52.8 (−61.3, −42.5)	−42.3 (−57.8, −21.5)	−53.7 (−68.8, −31.4)	−38.7 (−46.9, −29.4)	−9.9 (−25.6, 8.6)
Postdischarge Mortality§						
Absolute change	3.0 (1.3, 5.3)‡	1.7 (0.8, 2.6)‡	1.4 (0.4, 2.9)†	0.7 (−0.6, 2.6)	2.3 (1.4, 3.5)‡	3.8 (2.2, 5.8)‡
Relative change	108.3 (47.9, 190.2)	60.2 (28.9, 94.6)	73.5 (18.6, 151.4)	24.1 (−18.5, 86.8)	74.7 (43.9, 112.1)	126.7 (73.9, 193.3)
30-Day Mortality						
Absolute change	−0.6 (−3.4, 2.5)	−1.4 (−2.5, −0.1)*	−0.3 (−1.9, 1.8)	−1.6 (−2.8, 0.0)*	−0.5 (−2.1, 1.3)	+4.3 (1.8, 7.1)‡
Relative change	−3.0 (−16.4, 12.0)	−15.3 (−27.3, −1.5)	−3.6 (−24.7, 22.8)	−26.0 (−45.2, −0.7)	−3.4 (−14.0, 8.6)	+33.8 (+14.4, +55.6)

*Absolute and relative change significant at $P < 0.05$.

†Absolute and relative change significant at $P < 0.005$.

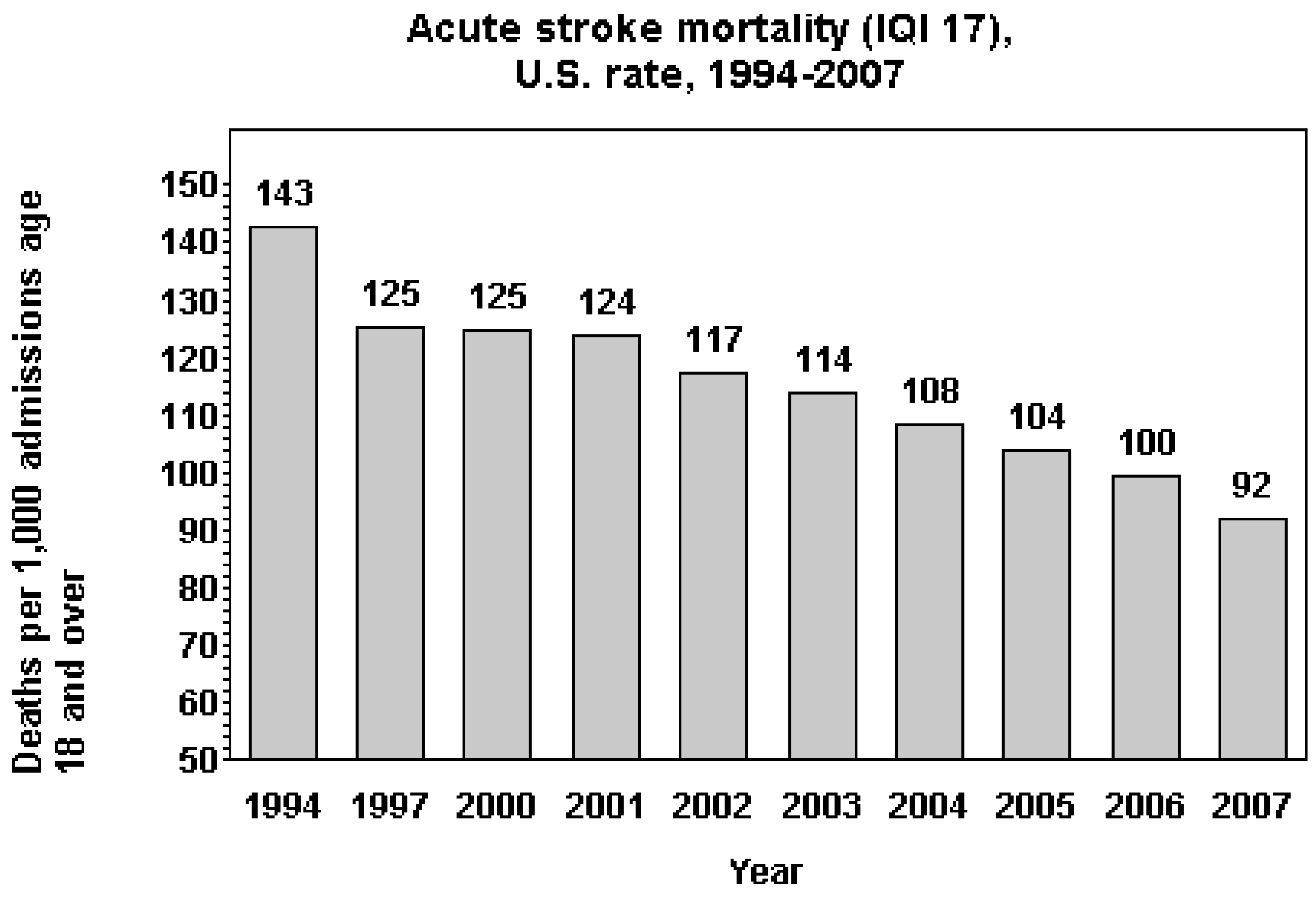
‡Absolute and relative change significant at $P < 0.001$.

§Defined as the period between hospital discharge and 30 days after admission.

Baker D, et al. Medical Care 2002;40(10):879-90

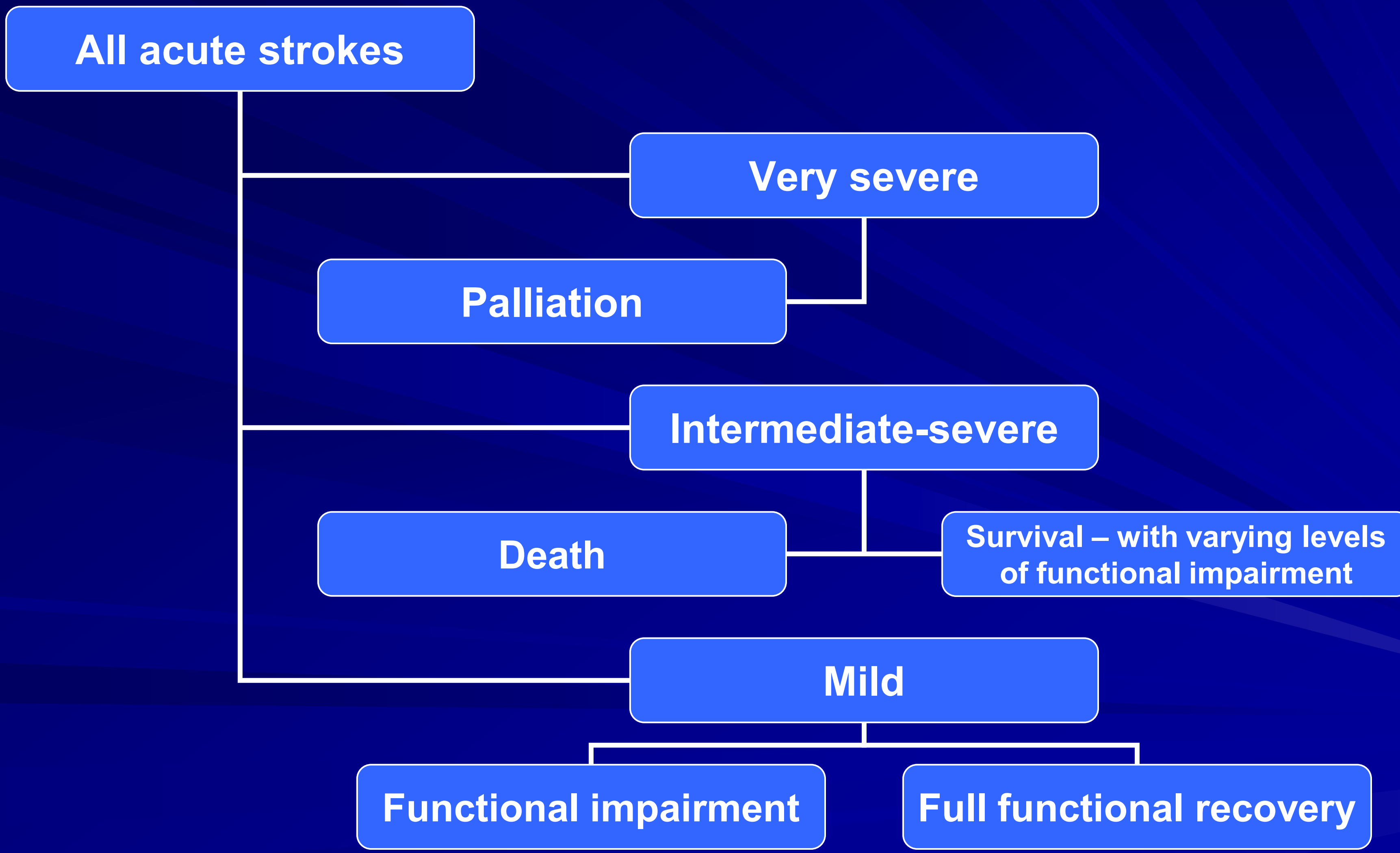
Mean LOS for stroke decreased from 10.4 to 6.3 days

Not reassuring



Adjusted by age, gender, and APR-DRG risk of mortality score.
Source: AHRQ, HCUP, Nationwide Inpatient Sample and AHRQ QIs Version 3.1

Other outcomes are more important than mortality



Shouldn’t mix different types of strokes

- Cohorts should be defined in a manner relevant to patients (clinical syndromes)
  – Understandable to patients
  – Inform the choices that patients, pre-hospital providers, and payers need to make
- Precedents are well-established
  – Heart failure, not systolic vs. diastolic
  – ACS or AMI, not NSTEMI vs. STEMI
- Exclusion based on diagnostic test results obtained after admission MAY be problematic

Risk-adjustment, Stratification

IN-HOSPITAL MORTALITY	Observed	Bias ratio
Overall	11.28%	1
Hemorrhagic alone	32.85%	1.04
Ischemic alone	6.73%	0.97
Subarachnoid	28.84%	1.01

- Composite reporting to the "public" does not preclude stratified reporting to providers
- Composite reporting to the "public" does not preclude stratified risk-adjustment (i.e., fully saturated models)

Conclusions

- Risk-adjusted mortality is one of many potentially valid outcome measures for acute stroke care
- Risk-adjusted mortality is relevant to patients and providers, and may be informative for care improvement
- “Straw man” arguments notwithstanding, transparency and accountability are core values in publicly financed health care

Ernest Codman, MD

- So I am called eccentric for saying in public: that Hospitals, if they wish to be sure of improvement, (1) must find out what their results are; (2) must analyse their results, to find out their strong and weak points; (3) must compare their results with those of other hospitals; … and (8) must welcome publicity not only for their successes but for their errors…. Such opinions will not be eccentric a few years' hence. —

Codman EA. *A Study in Hospital Efficiency as Demonstrated by the Case Reports of the First Five Years of a Private Hospital.* Boston: Todd; 1916.