Hospital Profiling With Enhanced Risk Adjustment Based On Laboratory Tests And Vital Signs Data

Ann Borzecki, MD MPH
Amresh D. Hanchate, PhD
CHOIR
VA Bedford & Boston

Acknowledgements

- Funding: VA HSR&D - IIR 08-351 (PI: Hanchate)
- Co-investigators:
  - Arlene Ash, PhD (University of Massachusetts)
  - Aaron Fink, MD (VA Atlanta)
  - Mary Jo Pugh, PhD (VA San Antonio)
  - Amy Rosen, PhD (CHOIR, VA Boston)
  - Michael Shwartz, PhD (CHOIR, VA Boston)
  - Hassen Abdulkerim, MS (CHOIR, VA Boston)
  - Kelly Stolzmann, MS (CHOIR, VA Boston)

Aims

- Examine impact of adding laboratory tests + vital signs to administrative data for hospital profiling
- Evaluate whether this leads to improved measures of hospital quality

Background

- Adding clinical data to administrative data
  - Pine et al. (JAMA 2007): 188 Pennsylvania hospitals
  - Tabak et al. (Med Care 2007): 266 hospitals Cardinal Health database
  - Escobar et al. (Med Care 2008): 17 Kaiser hospitals
  - Render et al. (2003; 2010): VA hospitals - ICU & AMI, Heart Failure & Pneumonia
- Findings
  - Significant increase in risk prediction model (e.g., sizable increase in c-statistic)
  - Changes in hospital profiles
- Better measure of hospital quality?

Data & Study Population

- Data
  - VA National Patient Care Data, FY2006-2010: Inpatient Patient Treatment File (PTF) and Outpatient Encounter File
  - VA Decision Support System (DSS) National Data Extracts (NDE), FY2007-2010: Laboratory Results (LAR)
  - Corporate Data Warehouse Vital Signs, FY2007-2010
  - VA Vital Status File, FY2011
- Study Population
  - CMS/VA Hospital Compare protocol for identifying discharges for AMI, HF and pneumonia
  - Exceptions:

    a) Age 18 and older

    b) Hospitals with at least 50 discharges

Hospital Counts & Outcome

	Acute Myocardial Infarction	Heart Failure	Pneumonia
No. of hospitals	91	128	131
No. of discharges	22,608	59,595	62,996
Median no. of discharges per hospital [range]	193 [53, 1202]	435 [55, 1758]	428 [50, 1586]
Median 30-day mortality rate per hospital [range]	9.9% [3%, 26%]	8.0% [3%, 15%]	9.7% [4%, 19%]

Laboratory Tests & Vital Signs

Laboratory Tests

- Hematology
  - Hemoglobin
  - Hematocrit
  - White Blood Cell Count
  - Prothrombin Time
  - Partial Thromboplastin Time

Vital Signs

- Temperature
- Pulse
- Systolic Blood Pressure
- Diastolic Blood Pressure
- Respiratory Rate
- Pulse Oximetry

- Chemistry
  - Sodium
  - Potassium
  - Bicarbonate (HCO3/CO2)
  - Glucose
  - Creatinine
  - Bun
  - Albumin
  - AST
  - Bilirubin
  - Alkaline Phosphatase
  - Troponin

Risk Measures from Laboratory Tests & Vital Signs

- Identified all laboratory tests and vital signs within 24 hours of admission time
- In case of multiple tests, most extreme result selected
- Based on clinical judgment and bivariate association with 30-day mortality, categorized each test result into 5 categories: 1) Normal, 2) Low abnormal, 3) Moderate abnormal, 4) High abnormal, 5) Missing
- In final models, excluded measures for which none of categories significantly associated with 30-day mortality

Example of Lab Test Measure

Test Measure *	AMI Cohort	
Creatinine (mg/dl)	**Definition**	**Hosp. Prevalence Median % (range)**
Normal (OR not diff. from 1)	(0.81-0.90)	4.7 (0-11.7)
Abnormal Low (OR >1, ≤2)	(0.20-0.80) & (0.91-1.20)	39.2 (8.3-57.1)
Abnormal Moderate (OR>2, ≤3)	(1.21-1.30)	7.1 (0-12.6)
Abnormal High (OR>3)	(1.31-35)	38.2 (6.9-65.3)
Missing		3.5 (0-81.9)

- Categories derived by logic regression of 30-day mortality on decile indicators and defined based on odds ratios (OR) as shown

Missingness Rates

- Post-2007, missingness stabilized for most laboratory tests and vital signs
- Missingness rates varied across
  - Conditions
  - Hospitals

Final Models

- For each admission cohort
  - Administrative data model = CMS/VA Hospital Compare model
  - Enhanced model = Administrative + laboratory test + vital signs
- Hierarchical logistic model with unobserved hospital effects
- Risk adjusted hospital mortality rates (RSMRs)

Model Performance

	Administrative Data Model	Enhanced Data Model
AMI	0.79	0.85
Heart Failure	0.73	0.81
Pneumonia	0.76	0.82

* C-statistics are shown

Comparison to Prior VA Study

	Current Study		Prior Study (Render, 2010)	
	Admin. Data Model	Enhanced Data Model	Admin. Data Model	Enhanced Data Model
AMI	0.79	0.85	0.77	0.82
Heart Failure	0.73	0.81	0.71	0.79
Pneumonia	0.76	0.82	0.74	0.80

Impact on Hospital Profiles

- Change in hospital risk standardized mortality rates (RSMRs)
- Does adding clinical data result in improved measures of hospital quality?

Absolute Change in Hospital Risk Standardized Mortality Rates (RSMR)

% Absolute Change in RSMR after Adding Clinical Data	Admission Cohort		
	AMI (N=91)	HF (N=128)	Pneumonia (N=131)
<10%	69 (75%)	94 (73%)	96 (73%)
10% to 20%	20 (22%)	29 (23%)	27 (21%)
>20%	2 (2%)	5 (4%)	8 (6%)

Relative Change in RSMRs: Heart Failure Cohort (N=128)

RSMR without Clinical Data	RSMR with Clinical Data			
	Q1 (low mortality)	Q2	Q3	Q4 (high mortality)
Q1	24	8	0	0
Q2	7	17	16	0
Q3	1	5	16	10
Q4	0	2	8	22

Discordant Proportion (%)

AMI = 48%; HF = 42%; Pneumonia = 42%

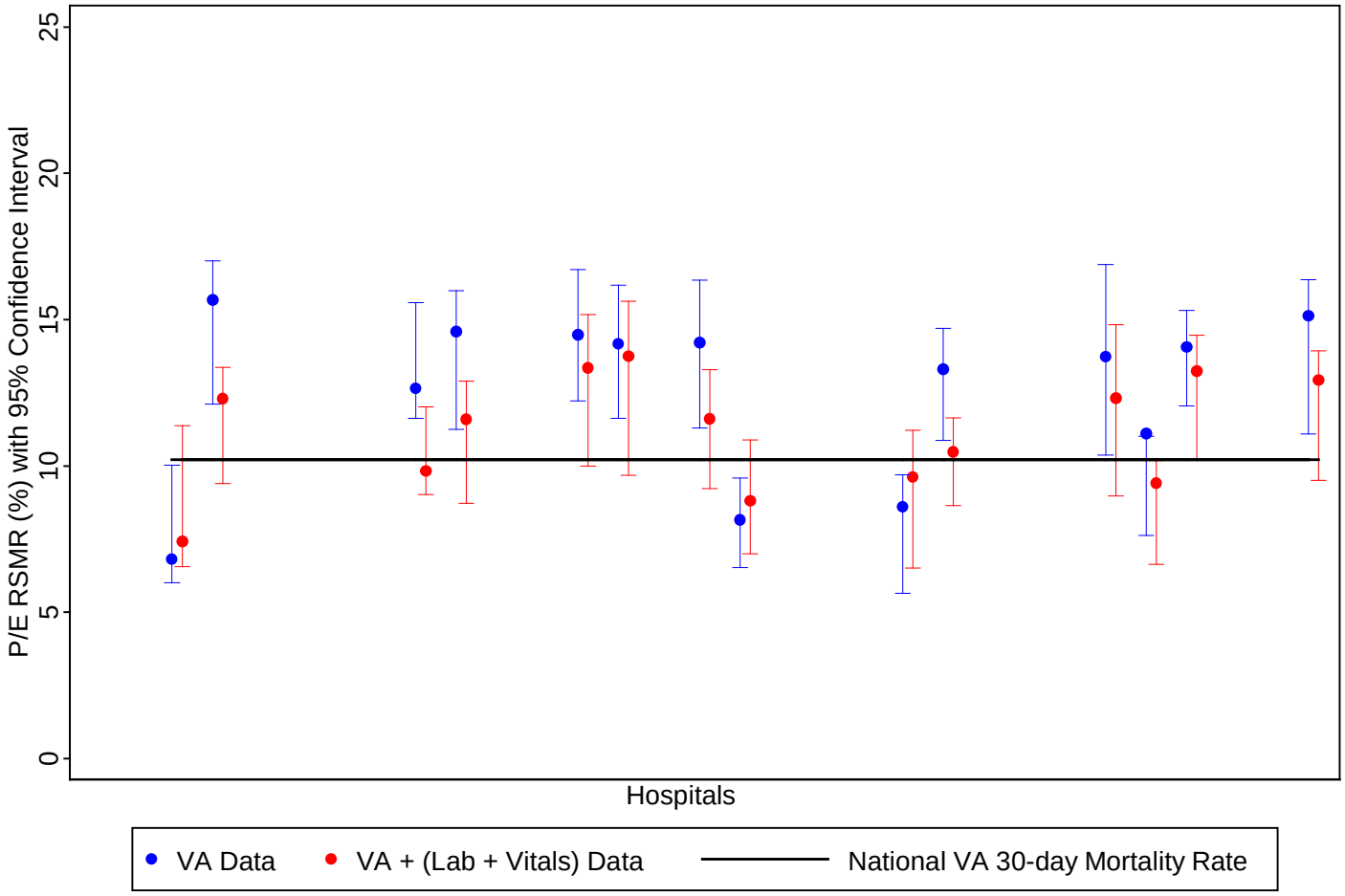
Change in Hospital Compare Designation: Pneumonia Cohort (N=131)

Without Clinical Data	With Clinical Data		
	Better than VA national rate	No different than VA national rate	Worse than VA national rate
Better than VA national rate	5	3	0
No different than VA national rate	1	109	0
Worse than VA national rate	0	10	3

hospitals with change in designation:

AMI=5/91 HF=16/128 Pneumonia=14/131

Change in Hospital Compare Designation: Pneumonia Cohort



Does Adding Clinical Data Lead to Better Measures of Hospital Quality?

- Concerns about measuring hospital quality using administrative data
- Poor correlation
  - Mortality and Process measures
  - Mortality and Readmission measures
- Does adding clinical data improve correlation?

QUALITY

By Matthew J. Press, Dennis P. Scanlon, Andrew M. Ryan, Jingsan Zhu, Amol S. Navathe, Jessica N. Mittler, and Kevin G. Volpp

Limits Of Readmission Rates In Measuring Hospital Quality Suggest The Need For Added Metrics

DOI: 10.1377/hlthaff.2012.0518
HEALTH AFFAIRS 32,
NO. 6 (2013): 1083–1091

RSMR and ORYX Composite Score: Quartiles (Matched admission cohort)

	Concordance of quartiles Kappa statistic		
	AMI (N=91)	HF (N=128)	Pneumonia (N=131)
RSMR Base Model	-0.01	-0.08	0.03
RSMR Enhanced Model	-0.01	-0.03	0.05

* Denotes $p<0.05$

Source of ORYX Composite Scores: 2012 VHA Facility Quality and Safety Report, Office of Quality, Safety and Value, Department of Veterans Affairs , 2012

RSMR and Readmission Rates: Quartiles (Matched admission cohort)

	Concordance of quartiles Kappa statistic		
	AMI (N=91)	HF (N=128)	Pneumonia (N=131)
RSMR Base Model	0.03	0.08	0.06
RSMR Enhanced Model	0.03	0.08	-0.01

* Denotes $p<0.05$

Source of Readmission Rates: 2012 VHA Facility Quality and Safety Report, Office of Quality, Safety and Value, Department of Veterans Affairs , 2012

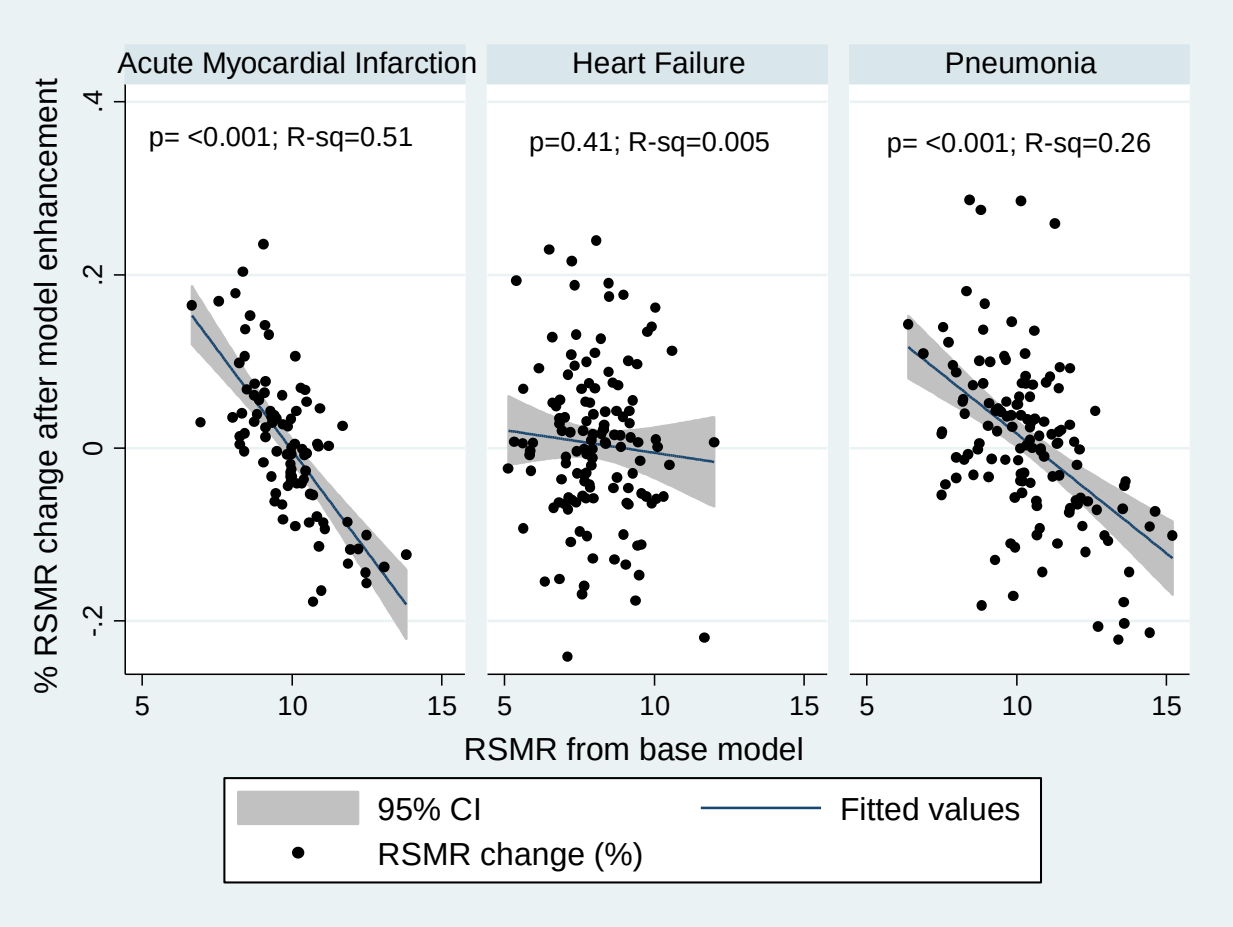
RSMRs in 2007-08 and 2009-10 : Quartiles

	Concordance of quartiles Kappa statistic		
	AMI (N=91)	HF (N=128)	Pneumonia (N=131)
RSMR Base Model	0.09	0.06	0.19
RSMR Enhanced Model	0.03	0.16	0.18

Correlation between RSMR and Other Quality Measures

- RSMRs from clinical data did not result in a significant change in concordance with
  - RSMRs from other admission cohorts
  - VASQIP Surgical Mortality O/E Rates
  - VASQIP Surgical Morbidity O/E Rates
  - Case volume

Change in RSMR after Adding Clinical Data: Regression to the Mean



Summary of Findings

- High rates of completeness of data on laboratory tests and vital signs, although missingness rates vary by facility
- Adding risk measures from laboratory tests
  - Improves performance of risk adjustment models
  - Changes relative hospital profiles
- Correlation of enhanced mortality performance measures with other hospital quality indicators remains poor

Discussion / Limitations

- No gold standard of hospital quality for comparison
- Quality is multifaceted
  - Limitations of comparison measures
- Small # hospitals
- However,
  - Absence of concordance with range of quality indicators remains an issue
  - Regression to the mean

Implications

- Need further research on ability of enhanced risk-adjusted mortality to distinguish hospital quality

Conclusions

- Use of data on laboratory tests and vital signs, in addition to administrative data, enables to better account for differences in patient status in measuring risk-adjusted 30-day mortality
- Concerns about lack of concordance of adjusted mortality with other hospital quality measures remain

Thank you

- Ann Borzecki (ann.borzeck@va.gov)
- Amresh Hanchate (amresh.hanchate@va.gov)

Missingness Rates

Year	Sodium	HCO3	Serum Creatinine	Bilirubin
2005	13%	100%	17%	32%
2006	13%	41%	20%	31%
2007	15%	32%	21%	37%
2008	13%	19%	18%	34%
2009	9%	11%	17%	35%
2010	8%	10%	18%	31%

Variation in Missingness

- Considerable missingness across hospitals for all tests
- Different hospitals had high missingness in different tests
- High missingness was weakly correlated with hospital volume