National Surveillance of Acute Kidney Injury Following Cardiac Catheterization

Michael E. Matheny, MD, MS, MPH
Associate Director for Data Analytics, VINCI
Associate Director, Advanced Fellowship in Medical Informatics
Tennessee Valley Healthcare System VA

Director, Center for Population Health Informatics
Vanderbilt University Departments of Biomedical Informatics, Medicine, and Biostatistics

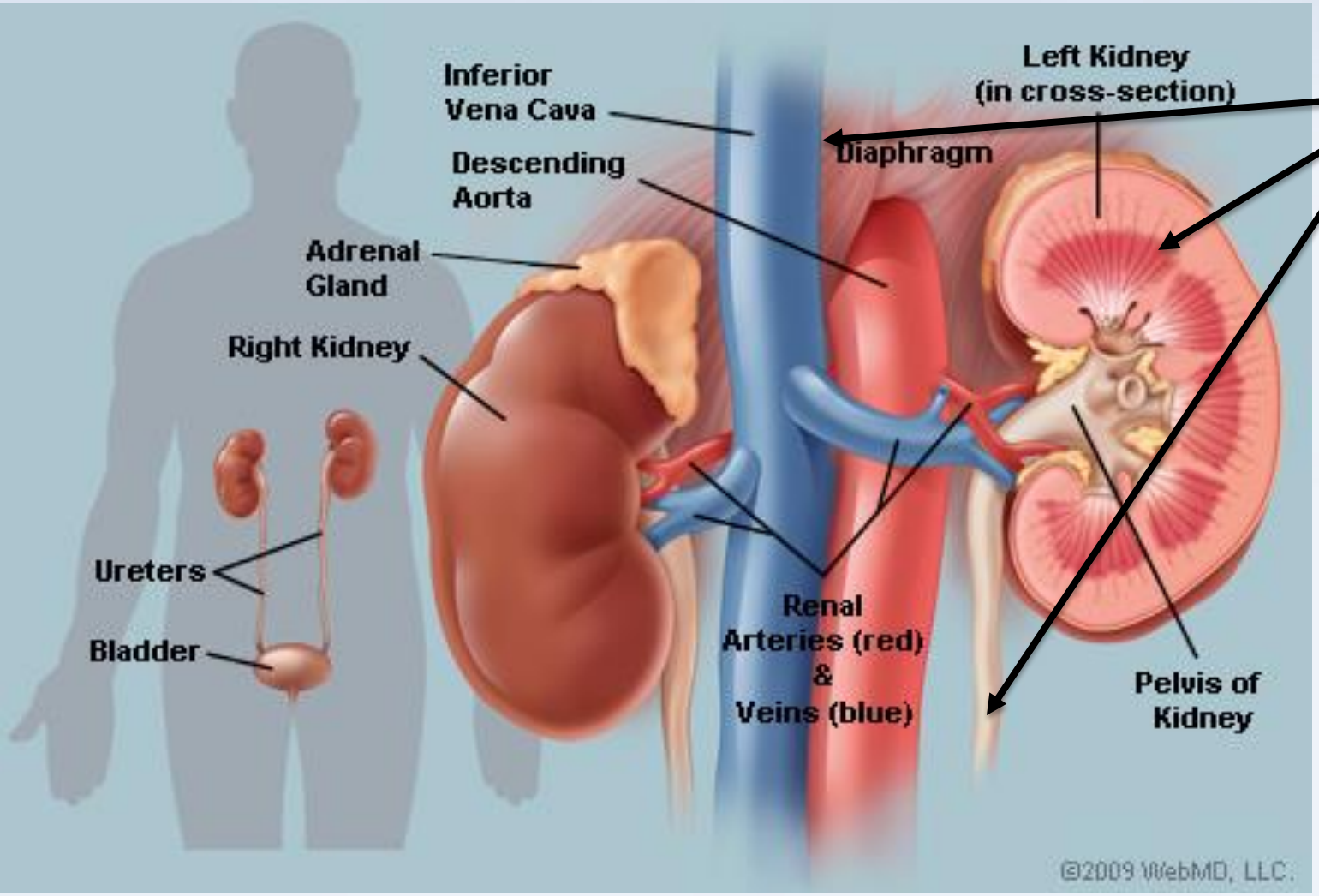
Outline

- Background
- Specific Aims
- Study 1: AKI Risk Factor Natural Language Processing
- Study 2: National Post-Procedural AKI Risk Prediction Modeling
- Study 3: Risk-Adjusted AKI Institutional Variation Surveillance
- Conclusion

AKI Definition

- Acute Kidney Injury (AKI) is defined as a loss of effective renal function resulting in an increase in creatinine, which is made by muscle tissue and cleared by the kidney, or a significant decrease in urine output

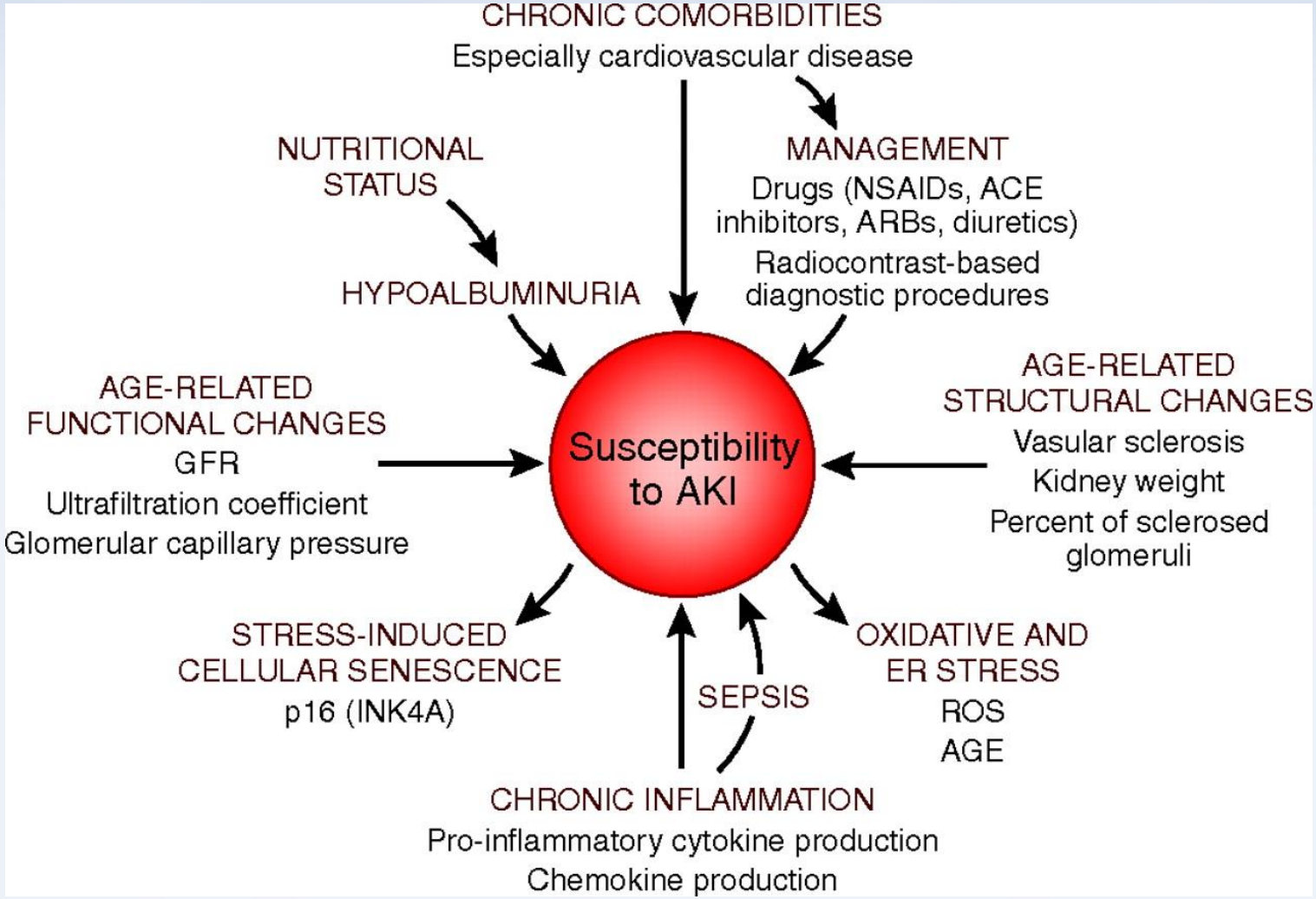
Categories of AKI



Pre-Renal (20%)
Intrinsic (70%)
Post-Renal (10%)

Source: Liano F, et al. Kidney Int. Suppl. 1998,66:S16-2

Potential Contributors to Susceptibility to AKI



Anderson S et al. JASN 2011;22:28-38

Additional References:
Himmelfarb Semin in Nephrol 2009: 29(6):658-64
Fuiano Kid Int 2001 59(3):1052-8
Rowe J Geron 1976; 31(2):155-63

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Post Cardiac Catheterization AKI

- ~1.3 million catheterizations in the U.S. yearly
- Up to 15% of these procedures experience AKI
- Significant Morbidity and Mortality:
  - Mortality: OR 2.4 (2.0-2.9)
  - Major Adverse Cardiac Events: OR 2.4 (1.6-3.6)
  - End Stage Renal Disease: OR 8.0 (3.2-20.2)
- Highly variable clinical practice because of uncertainty regarding best practice:
  - post-procedural AKI varied from 2 to 10% in the NNE population

Source: Brown et al. BMJ Quality & Safety. 2012;21:54-62
James et al. Circ Cardiovasc. Interv. 2013;6:37-43

Risk Modeling & Risk Adjustment

- With emergence of “big data”, strong need for leveraging patient data for personalized medicine for individual patients and improved risk-adjustment for population health management

- One of the challenges of adequate risk adjustment for adverse outcome surveillance is ascertainment of risk factors not in the structured data

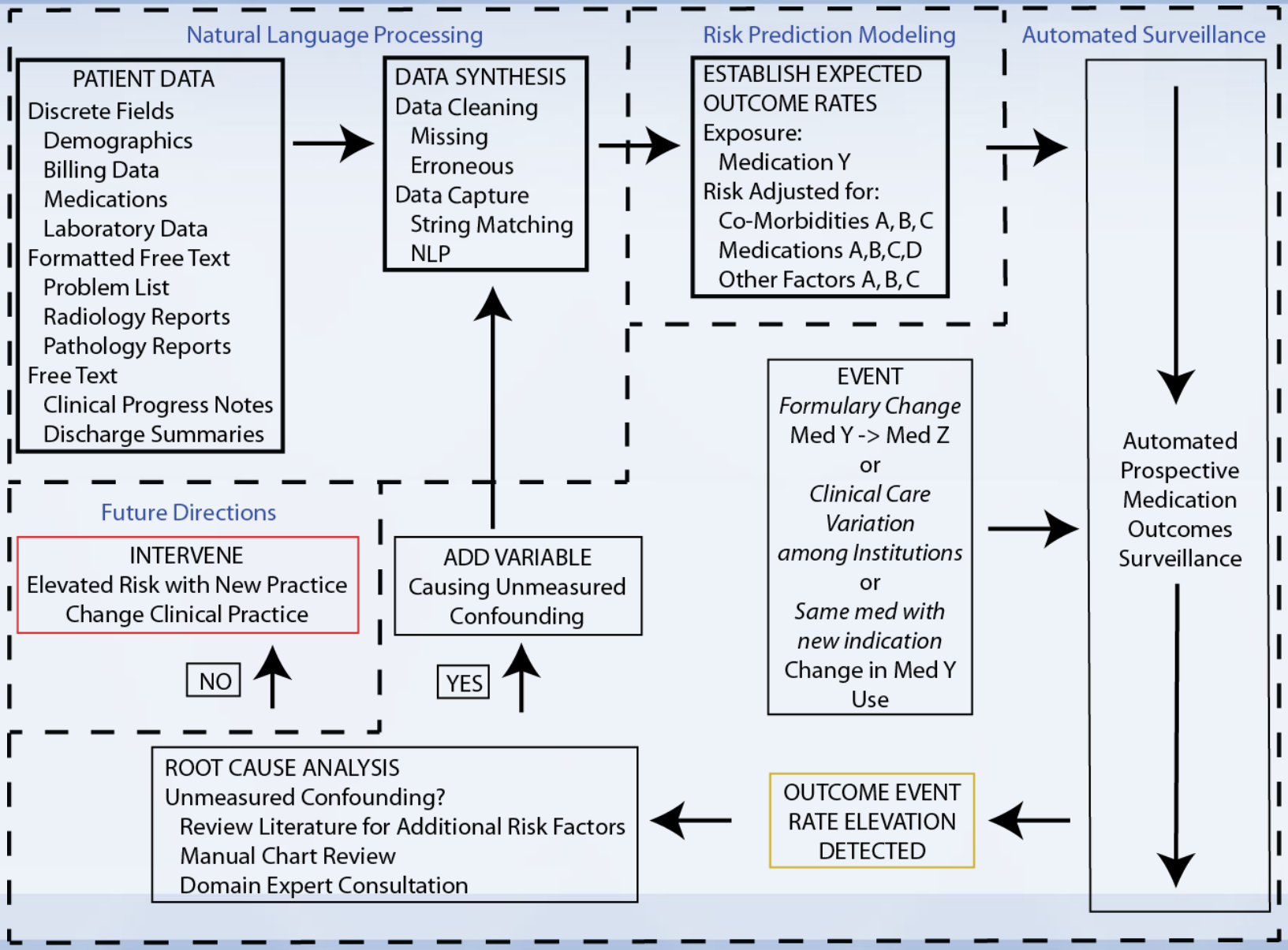
Natural Language Processing

- Natural Language Processing has a large body of research in the medical field for 25 years, but widespread use outside of informatics community has not been achieved
  - Difficult to train and validate
  - Difficult to use
  - Difficult to integrate with health services research and clinical operations
  - Inability to process documents at enterprise scale

Clinical Care Variation Surveillance

- Detecting and performing review of risk-adjusted outcome rate variation between institutions and providers is a critical step in quality improvement to reduce care delivery variation and identifying missing variables needed in the risk-adjustment strategy

Conceptual Framework



Study Population & Setting

CART Program

- Clinical Assessment, Reporting, and Tracking Program (CART) – national quality initiative for VA cardiac catheterization laboratories

- Initial pilots in 2005, by 2008, all VA labs were using the application

CART Clinical Application - User Interface

ZZTEST,PATIENT
000005542 01/01/1970 45
New Report | Outpatient | Last Hospital Admission: Discharged:

Presentation | History | Tests | Physical Exam | Medications | Labs | Sedation/Consent | Summary

Assessment Date: 7/1/2014
Assessed by: TSAI,THOMAS T
Attending: TSAI,THOMAS T
Case Number:
Referred by: Bradley, Steven
Referring Institution: Cheyenne

Clinical Presentation
54 yo with h/o 6 vessel CABG here with unstable angina.
Also, recent PCI April 2013 to RCA. 2001 CABG....etc...(free text)

Free text entered in CART will be included with the CART note which goes back to CPRS.

Primary Diagnosis: NSTEMI
Onset of Symptoms: 48 hours to 7 days
Comments: This is as much narrative as you want.
NYHA Functional Class: I
Cardiogenic Shock: No

Reports | Pre-Procedure Assessment | Cath/Other | PCI | Discharge Note
TGuiControl::DataChange | Presentation.CardiogenicSho | DataValue | cbxCardiogenicShock:TC

- Support clinical workflow
- collect standardized data (ACC mapped)
- CPRS-Integrated

ZZTEST,PATIENT
000005542 01/01/1970 45
New Report | Outpatient | Last Hospital Admission: Discharged:

Presentation | History | Tests | Physical Exam | Medications | Labs | Sedation/Consent | Summary

Prior Cardiac History
CHF: Yes
MI: Yes — Most recent:
PCI: Yes — Most recent: 2010
CABG: No — Most recent:
Valve Surgery: No — Most recent:
Valve Treatment (TVT): — Most recent:
Cardiac Transplant: Yes — Most recent: 01/01/2011
Cardiac Cath: Yes — Most recent: — Result: 3 vessel CAD
Comments

Comorbid Conditions
Peripheral Vascular Disease: — Cerebrovascular Disease: Unknown — Chronic Lung Disease:
Depression: — Sleep Apnea: Unknown
PTSD: Yes — Chronic Kidney Disease: Yes — On Dialysis: No
Comments

Cardiac Risk Factors
Dyslipidemia: Unknown — Hypertension: No
Diabetes: Yes — Diabetes Therapy: Insulin
Family History of CAD (Age < 55): Yes
Tobacco Use: Current — Alcohol Abuse: — Illicit Drug Use:
Comments

Reports | Pre-Procedure Assessment | Cath/Other | PCI | Discharge Note
TGuiControl::DataChange | RiskFactorComorbid.CVD | RiskFactorStatus | cbxCVD:TComboBox

Patient Cohort

- National VA cohort of 222,669 patient catheterizations between 01/2009 and 10/2013 within 71 medical centers
- Data collection began 01/2008
  - Integration of data sources including national corporate data warehouse, directly from ViSTa/CPRS for data lagged in CDW, and data from the CART Program.
  - Initial builds and analyses static retrospective data with work finishing up now to conduct the analyses with near real-time prospective data

Development and Validation of A Near Real-Time Natural Language Processing Tool to Extract Risk Factors for Post-Procedural AKI

NLP Project Methods Outline

- Develop & Evaluate Document Selection
- Develop Annotation Schema
- Conduct & Evaluate Document Annotation
- Develop & Evaluate RapTAT NLP Extraction Module for Accuracy and Speed

Study Population

- Initial Adult Coronary Angiography Cohort (n= 222,669)
  - Include all patients with at least one document from -90 to -1 days relative to date of cardiac catheterization
  - Include patient age >= 40 years at the time of catheterization
- Final Cohort (n=158,432)

Document Selection (Filtering) Methods

- Document Inclusion/Exclusion Criteria:
  - Include all documents -90 to -1 days relative to date of cardiac catheterization
  - Include all notes authored by Clinical Providers (MD, DO, NP, PA, or student of these disciplines)
  - Exclude documents smaller than 250 bytes
- Develop and Validate Document Content Categorization Algorithm

Cardiac Catheterization Pre-Procedural Note	Emergency Department Note
Inpatient H&P/Consult/Pre-Procedure	Procedure/Operative/Surgery
Inpatient Progress/Post-Procedure	Inpatient Discharge Summary
Outpatient Progress/Consult/H&P/Post-Procedure Note	

- Stratified Sampling Strategy
  - 3:1 Male to Female Ratio (female patient oversampling)
  - 3:1 Age 61+ to Age 40-60 Ratio (young patient oversampling)
  - Allow only one document per patient (minimize inter-document correlation)
  - Equal sampling of 7 document categories (balance distinct documentation content & styles)

Document Selection (Filtering): Results

- Initial Document Corpus: 9,007,164 Documents
- Filtered Document Corpus: 1,256,685 Documents
- Final Annotation Corpus
  - 39 Stratified Blocks Sampled (4,368 Documents)
  - 112 Documents per Block
- Document Categorization Algorithm Performance
  - Random 2% Excluded Document Manual Review: 97% Accuracy
  - 100% Included Document Manual Review: 92% Accuracy, exclusion or wrong category documents replaced using sampling strategy & reviewed to reach 100% accurate document category for annotation sample

Annotation Schema: AKI Clinical Variable Targets

Clinical Variable	Attributes *	Definition	Examples
Renal Function Impairment*	Chronicity: Acute, Chronic, Acute-on-Chronic, Unstated	Damage that reduces the functioning of the kidney, renal injury, or insufficiency, or kidney disease at any stage of progression	"Acute Kidney Injury", "Nephropathy", Renal Tubular Acidosis, "Nephrotic Range Proteinuria"
Anatomical Kidney Status	State: Solitary, Nonfunctioning, Atrophic, Surgically Removed, Other	Assessment of an anatomical abnormality of the kidney, regardless of etiology	"Hydronephrosis", "Nephrectomy", "Kidney Donor", "Renal Mass"
Renal Transplant Recipient		Kidney that has been or will be transplanted into the patient	"Kidney Allograft", "Renal Rejection", "Renal Transplant Recipient"
Nephrology Care Delivery	Type: General, Transplant, Dialysis	Renal care delivery whether it is care by a single provider or by a renal team	"Hemodialysis", "Renal Consult", "Nephrology Clinic", "Renal Transplant Clinic"
NSAIDs		NSAID medication, excluding aspirin	"Meloxicam", "Ketorolac","Celecoxib"
ACE Inhibitors		Angiotensin converting enzyme inhibitors (ACE)	"Enalapril", "Mavik"
ARB		Angiotensin II receptor blockers (ARB)	"Diovan", "Losartan"
Diuretic		All diuretics: loop, thiazide, potassium sparing, etc.	"Furosemide", "Spirinolactone"
Diuresis		A diuresis treatment, i.e., the act of diuresing	"diuresing", "forced diuresis"
Intake	Change: Increase, Decrease, Neutral Fluidity: Solid, Liquid, Both, Unstated Agency: Provider or Patient Initiated Delivery: IV, Oral, Unstated	Fluiid or solid intake, regardless of route.	"Fluid resuscitate", "no change in appetite", "fluid restriction", "intolerate of PO", "NPO"
Intravascular Volume	Status: Low, High, Normal	Patient's state of hydration or volume status within circulatory system	"Hypovolemia", "volume contraction", "isovolemic", "dry oral mucous membrane"
Weight Change	Status: Increase, Decrease, Neutral	Changes in patient's weight	"fluctuating weight", "cachectic", "weight loss", "weight gain"
Nausea/Vomiting/Diarrhea		Nausea, vomiting, and/or diarrhea, in any combo	"NVD", "N/V/D", "emesis"
Contrast Volume	Volume: value	Volume of contrast used in procedure	"270 ml of contrast", "300ml of Gadovist"
Contrast Exposure	Certainty: Confirmed or Potential Type: Radiocontrast, MRI	Radiocontrast media use in procedures and radiology tests	"Cardiac Catheterization", "CTA", "Renal angiography"

* All variables include standard attributes: Assertion (Negation, Uncertainty), Time Frame (Past, Present, Future), Experiencer (Patient, Non-Patient)

Annotation Example

eHOST V1.179 @2013.03.10

Result Editor | SYSTEM Setting | Sync Assignments | EXIT

NAVIGATOR

16 Classes: [7/7 annotations]

- ACEInhibitor [1/1]
- ARB
- AnatomicalKidneyStatus
- ContrastExposure
- ContrastVolume
- Diuresis
- Diuretic [1/1]
- Intake
- IntravascularVolumeConditio
- NSAID
- NauseaVomitingDiarrhea [2/
- NephrologyCareDelivery
- PotentialContrastExposure
- RenalFunctionImpairment
- RenalTransplantRecipient
- WeightChange [1/1]

3 Public Attributes:

Relationships:[0/0]

Current Note | All Notes

Document Viewer

Block_03_Note_002.txt

Text Display | Annotation Information | Reports

Patient had AV fistula done last month for possible dialysis, but has not required dialysis as of yet. Had decreased appetite, but no other signs of uremia. No other electrolyte disturbances. As stated above was rehydrated with normal saline throughout most of hospitalization. BMP followed daily. His renal function improved, discharge creatinine was 3.1. He was continued on his weekly Darbepoetin and iron supplements.

3) Hypertensive Urgency - BP was elevated to 200's/70s in ED, he was given

Find

EDITOR

Annotation Editor

Selected Annotations:

normal saline

Span: 4981 | 4994 : normal

Class: Intake

Comment:

Attributes:

"AssertionStatus" = Postive
"Experiencer" = Patient
"TimeFrame" = Prior
"ChangeStatus" = Increase
"Fluidity" = Liquid
"IntakeAgency" = ProviderInitiated
"DeliveryMode" = IV

Project: D:\CARTCL-IIR\Annotation\Gentry\eHOSTAnnotationNancy\eHOST_AKI_Nancy_NoChangeSchema\AKI_GentryProject\AKI_Block3_Nancy.

Annotation Mode | Adjudication Mode

Inter-Annotator Agreement

- 14 Annotated Blocks (1,568 documents) for Concept/Attributes
  - 9 Training Blocks / 5 Testing Blocks
  - 16 Concepts
  - 12 Attributes
- 5 Annotated Blocks for Assertion Cue/Scope

Comparison	Concept Only Agreement	Concept & Attribute Agreement
Annotator A versus Annotator B	91%	66%
Annotator A versus Adjudicator	96.2%	81.8%
Annotator B versus Adjudicator	95.2%	81.7%

NLP Performance Summary

Category	Instances	TP	FP	FN	Precision (PPV)	Recall (Sensitivity)	F Measure
Drug Exposures							
• ACE Inhibitor	575	553	8	22	0.986	0.962	0.974
• ARB	149	137	0	12	1.000	0.919	0.958
• Diuretic	733	684	4	49	0.994	0.933	0.963
• NSAID	233	201	4	32	0.980	0.863	0.918
Fluid Status							
• Diuresis	118	83	6	35	0.933	0.703	0.802
• Intake	694	412	46	282	0.900	0.594	0.715
• Intravascular Volume Condition	527	432	12	95	0.973	0.820	0.890
• Nausea/Vomiting/Diarrhea	719	674	25	45	0.964	0.937	0.951
• Weight Change	221	130	14	91	0.903	0.588	0.712
Radiographic Media Exposure							
• Contrast	2095	1858	240	237	0.886	0.887	0.886
• Potential Contrast	439	255	65	184	0.797	0.581	0.672
• Contrast Volume	4	0	0	4	-	0.000	0.000
Renal Status							
• Anatomical Kidney Status	57	9	4	48	0.692	0.158	0.257
• Nephrology Care Delivery	210	141	36	69	0.797	0.671	0.729
• Renal Function Impairment	449	368	44	81	0.893	0.820	0.855
• Renal Transplant Recipient	8	0	0	8	-	0.000	0.000
Total Concept Performance	**7231**	**5661**	**341**	**1570**	**0.921**	**0.821**	**0.868**

Category	Instances	TP	FP	FN	TN	Sensitivity	Specificity	NPV
Negation Performance		351	333	17	1049	0.954	0.759	0.984

Near Real-Time Processing Support

- Processing Speed: ~1 sec/ document on an single machine installation = 86,400 / day
- Process 1,256,685 documents from retrospective catheterization population from 2008-2012 for Specific Aims 2 & 3
  - Estimated Batch Runtime 14.5 days (fast!!)
  - Can easily keep up with prospective daily document volume (~23 minutes per day)

Aim 1 Conclusions

- NLP tools successfully extracted most of the targeted concepts at the desired accuracy
- A few concepts are not usable in subsequent risk adjustment modeling, mainly because of rarity of documentation
- Even after incorporating negation detection, we were able to maintain processing speed efficiency

Development & internal validation of risk prediction models for acute kidney injury following cardiac catheterization

Study Population

- Initial Adult Coronary Angiography Cohort (n= 222,669)
  - Exclude History Of Dialysis, ESRD Or Renal Transplant (n=6,998)
  - Exclude Missing 365 Day Pre-Procedural Serum Creatinine (n=21,014)
  - Exclude Missing 7 Day Post-Procedural Serum Creatinine (n=79,024)
- Final Cohort (n=115,633)

Risk Modeling Methods

- LASSO (L1) Logistic Regression
- Internally Validated using 200 bootstrap iterations
- Discrimination: AUC
- Calibration: O/E Plots

Source: Brown, JR, et al, Matheny ME. JAHA 2015;4:e002136

Candidate AKI Risk Factors

Patient Characteristics
Age
Non-white race
Tobacco use (any)
Prior tobacco use
Prior Comorbidities
0-1 days from catheterization
0-2 days from catheterization
Prior PCI
Prior CABG
Prior MI
Prior stroke
Diabetes
Dyslipidemia
Hypertension
Hypotension
Mitral regurgitation
Peripheral vascular disease

Number of Prior Comorbid Events
Number of prior admissions
CHF
CHF 7-365 days
CKD
Diabetes
Dyslipidemia
Hypertension
Hypoalbuminemia 7-30 days
Hypoalbuminemia 7-90 days
Hypotension
Peripheral vascular disease
Shock events
CHF events
CKD events
Dyslipidemia events
Prior Renal Complications and Function
Prior CKD
Prior AKI (KDIGO)
Prior highest AKIN Stage
Prior CIN (>0.5)
Prior ARF (ICD9)
Number of prior AKI admissions
Number of prior CKD admissions
Change in eGFR prior year
Decline in eGFR prior year
CKD
eGFR<60 (mL/min/m2)
eGFR<45 (mL/min/m2)
eGFR<30 (mL/min/m2)

Presenting Medication Use
ARB
ACE
Loop diuretic
K sparing diuretic
Statins
Aminoglycosides
Cimetidine
Cyclosporine
Nacetylcysteine
NSAIDS
Trimethoprim
Thrombolytic
Clinical Presentation
Elective
Urgent
Emergent
Salvage
Unstable angina
Shock
Hypertension
Hypotension
Ejection fraction <=40%
Acute coronary syndrome
Pre creatine-kinase>=100
Pre CKMB >=2.66
Pre-Present MI
Dyslipidemia
Anemia
1-999 (mL) IV fluids
1000+ (mL) IV fluids

Outcome Definition: AKIN Criteria

Category	Cr Criteria
AKIN Stage 1	≥150% or ≥ 0.3 mg/dL increase
AKIN Stage 2	≥200% increase
CIN	≥ 0.5 mg/dL increase
Dialysis	Acute dialysis

All outcomes were calculated using a 7 day post-procedural window

Source: Mehta et al. Critical Care 2007;11(2):R31.

Study Population

Patients (n = 115,633)	No AKI (99,596)	AKI (16,037)	OR (95% CI)
Patient Characteristics			
Age	65.2±9.5	67.2±10.0	1.02 (1.02-1.02)
Female	2.2	2.1	0.93 (0.83-1.05)
Non white race	22.8	26.7	1.23 (1.19-1.28)
Tobacco use (any)	38.7	34.1	0.82 (0.79-0.85)
Prior Comorbidities			
Prior catheterization	43.9	24.3	0.41 (0.40-0.43)
Prior PCI	33.5	25.5	0.68 (0.66-0.71)
Prior CABG	12.9	11.1	0.85 (0.80-0.89)
Prior MI	28.1	30.2	1.11 (1.07-1.15)
Prior stroke	7.9	8.5	1.08 (1.02-1.14)
Diabetes	48.5	51.8	1.14 (1.10-1.18)
Dyslipidemia	74.4	65.9	0.66 (0.64-0.69)
Hypertension	78.6	76.2	0.87 (0.84-0.91)
Hypotension	8.8	11.3	1.33 (1.26-1.40)
Peripheral vascular disease	19.2	22.8	1.24 (1.19-1.29)

Patients (n = 115,633)	No AKI (99,596)	AKI (16,037)	OR (95% CI)
Renal Function			
Prior CKD	13.1	24.4	2.14 (2.05-2.23)
Prior AKI (KDIGO)	11.0	29.8	3.45 (3.32-3.59)
Prior highest AKIN Stage			1.83 (1.78-1.87)
AKIN Stage 1	17.9	27.4	
AKIN Stage 2	2.5	7.7	
AKIN Stage 3	0.6	1.7	
Prior CIN (>0.5)	15.2	30.1	2.41 (2.32-2.50)
Prior ARF (ICD9)	6.5	15.5	2.64 (2.52-2.78)
CKD	6.9	13.4	2.07 (1.96-2.18)
eGFR<60 (mL/min/m2)	14.8	33.5	2.90 (2.79-3.01)
eGFR<45 (mL/min/m2)	5.0	18.1	4.17 (3.96-4.38)
eGFR<30 (mL/min/m2)	0.9	6.7	8.14 (7.43-8.92)
Presenting Med Use			
ARB	9.56	9.6	1 (0.95-1.06)
ACE	41.78	38.9	0.89 (0.86-0.92)
Loop diuretic	18.99	28.4	1.69 (1.63-1.76)
K sparing diuretic	5.77	7.7	1.37 (1.29-1.46)
Statins	62.03	54.2	0.72 (0.70-0.75)
Nacetylcysteine	2.6	1.7	0.67 (0.59-0.75)
NSAIDS	11.2	7.8	0.67 (0.63-0.71)
Thrombolytic Use	0.03	0.02	0.89 (0.31-2.53)

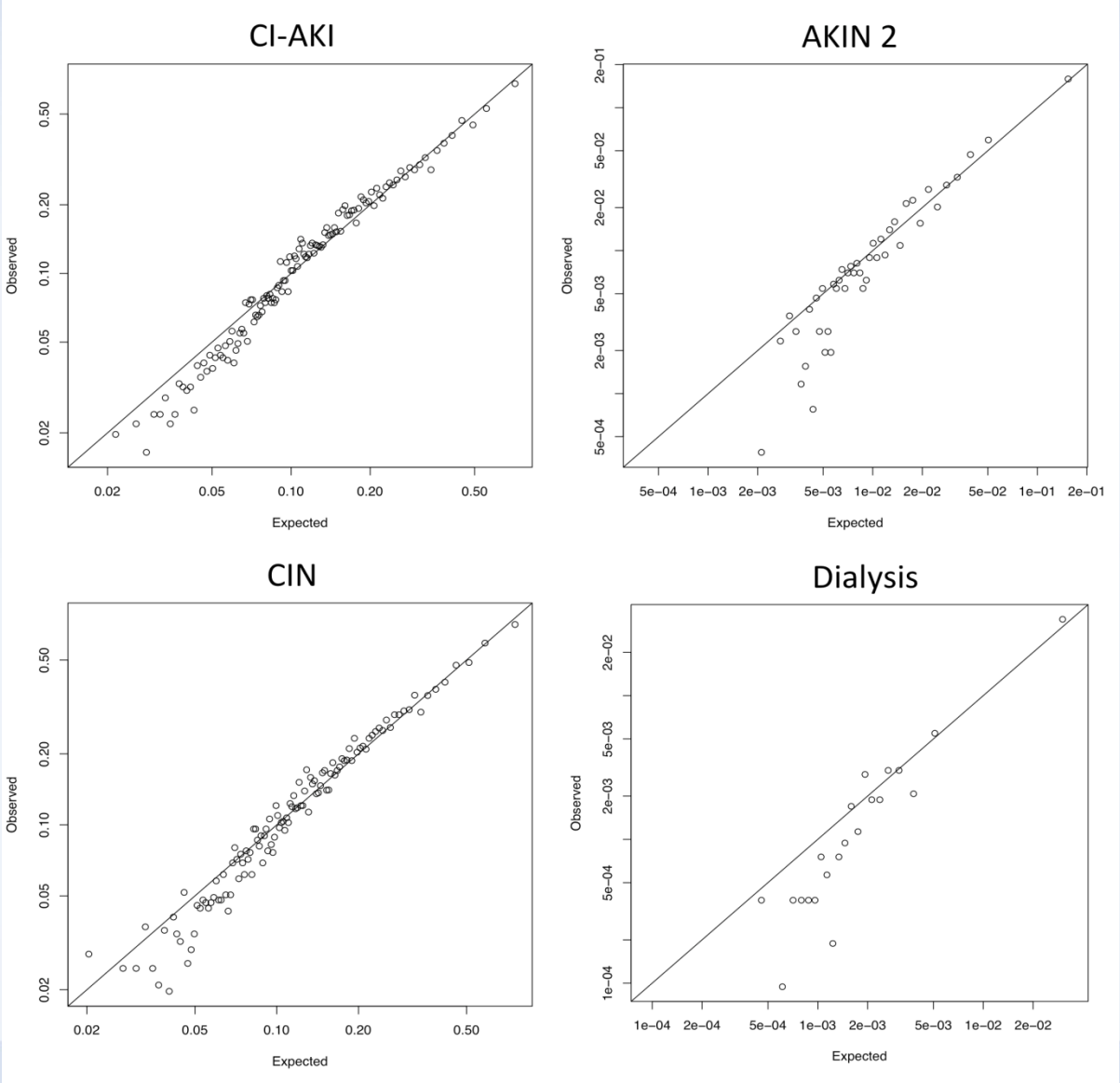
Outcome Rates

Outcome Definition	#	%
AKIN Stage 1	16,036	13.9%
AKIN Stage 2	2,017	1.7%
CIN	13,763	11.9%
Dialysis	476	0.4%

Outcome Rates

Outcome Definition	AUC (95% CI)
AKIN Stage 1	0.742 (0.738 – 0.747)
AKIN Stage 2	0.826 (0.816 – 0.836)
CIN	0.741 (0.737 – 0.746)
Dialysis	0.885 (0.870 – 0.902)

Results: Observed/Expected Plots



AKI Risk Prediction Model: AKIN Stage 2

Risk Factor	OR	95%CI
Patient Characteristics		
Age	1.00	(1.00-1.00)
Non white race	1.14	(1.09-1.18)
Tobacco use (any)	0.92	(0.88-0.97)
Prior Comorbidities		
Prior PCI	0.79	(0.76-0.82)
Prior CABG	0.87	(0.83-0.92)
Prior stroke	0.88	(0.83-0.93)
Diabetes	1.30	(1.25-1.36)
Hypertension	1.21	(1.15-1.26)
Number of Prior Comorbid Events		
CHF	1.14	(1.02-1.29)
CHF 7 365 days	1.23	(1.17-1.29)
Dyslipidemia	0.99	(0.98-0.99)
Hypoalbuminemia 7 90 days	1.33	(1.20-1.47)
CHF events	1.03	(1.00-1.05)
Prior Renal Complications and Function		
Prior AKI (KDIGO)	1.72	(1.59-1.86)
Prior highest AKIN Stage	1.24	(1.17-1.31)
Prior CIN (>0.5)	1.13	(1.05-1.21)
Change in eGFR prior year	0.99	(0.99-1.00)
Decline in eGFR prior year	1.01	(1.01-1.02)
eGFR<60 (mL/min/m2)	1.50	(1.41-1.60)
eGFR<45 (mL/min/m2)	1.37	(1.20-1.56)
eGFR<30 (mL/min/m2)	3.81	(1.82-8.00)

Risk Factor	OR	95%CI
Presenting Medication Use		
ARB	0.93	(0.88-0.98)
Loop diuretic	1.15	(1.09-1.21)
Statins	0.83	(0.80-0.86)
Cimetidine	0.55	(0.39-0.77)
Nacetylcysteine	0.78	(0.72-0.85)
Clinical Presentation		
Elective	0.60	(0.55-0.65)
Emergent	3.54	(2.96-4.24)
Salvage	8.05	(0.34-191.31)
Unstable angina	0.61	(0.58-0.63)
Shock	4.76	(1.99-11.39)
Hypertension	0.86	(0.83-0.89)
Hypotension	1.30	(1.24-1.35)
Acute coronary syndrome	1.13	(1.08-1.18)
Pre Present MI	1.10	(1.03-1.18)
Anemia	1.23	(1.18-1.27)

Aim 2 Conclusions

- Good model performance, comparable to prior risk models in this area
- Tailored to the VA population for individual risk prediction and risk adjustment
- A reduced variable version is being piloted as clinical decision support by the CART program to calculate pre-procedural risk assessment

Specific Aim 3

Objective: conduct automated national retrospective and prospective analyses for expected and suspected high risk AKI exposures and institutional care variation among veterans receiving cardiac catheterization using novel surveillance methods.

Study Cohort

- 71 Institutions - a few centers were clustered by VA sta3n (site)
- 111,995 catheterizations (after inclusion/exclusions)
- Overall AKIN Stage 1 AKI Event Rate was 14.2%

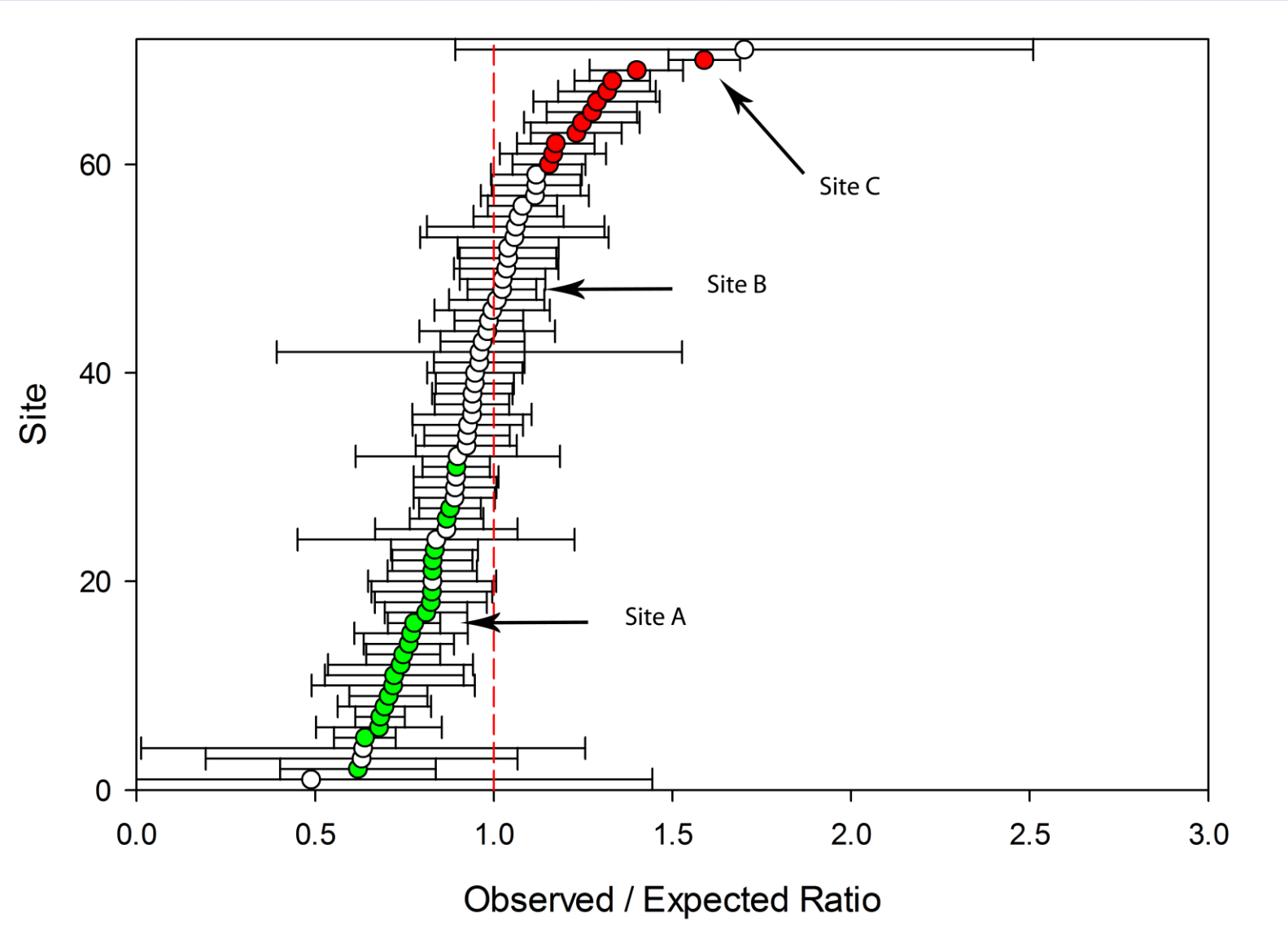
Source: Matheny ME, et al, Brown JR. *In Draft*

Study Methods

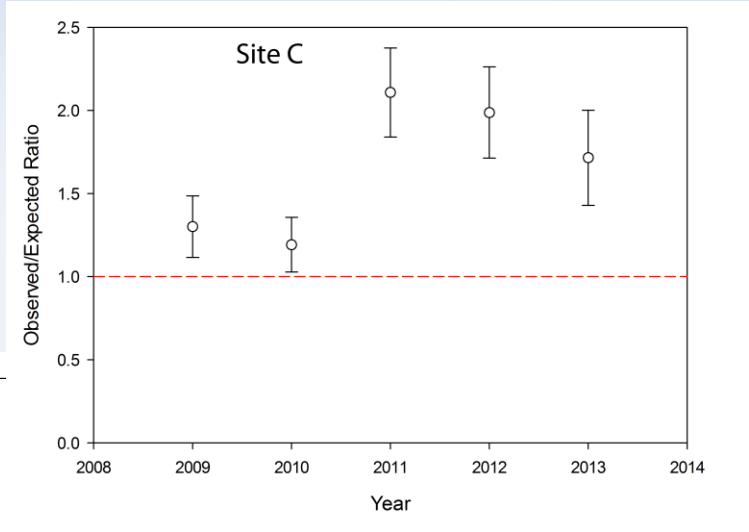
- Risk Adjusted Sequential Probability Ratio Testing
  - Testing OR 2.0 and 0.5
  - Alpha error = 0.05, beta error = 0.10
  - Risk adjustment: Rolling Prior 12 Month Logistic Regression using 42 clinical variables from Aim 1
- For comparison, calculation of observed/expected ratios per site with 95% confidence intervals

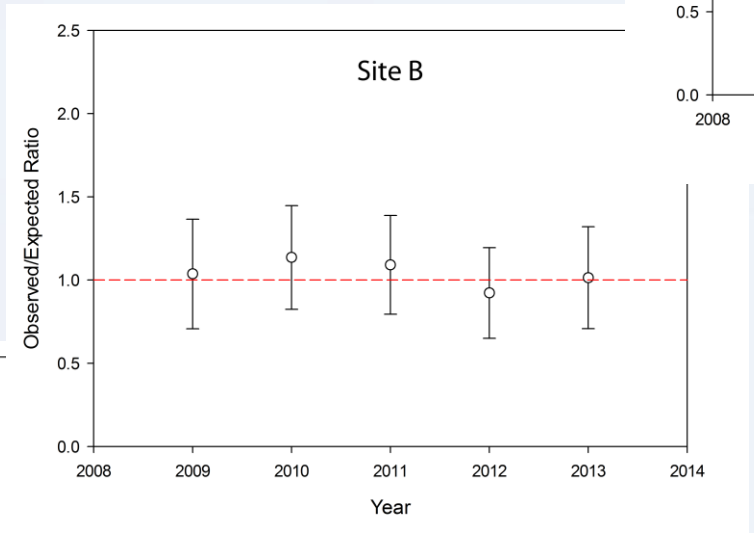
Source: Matheny ME, et al, Resnic FR. BMC Medical Informatics & Decision Making 2011;75

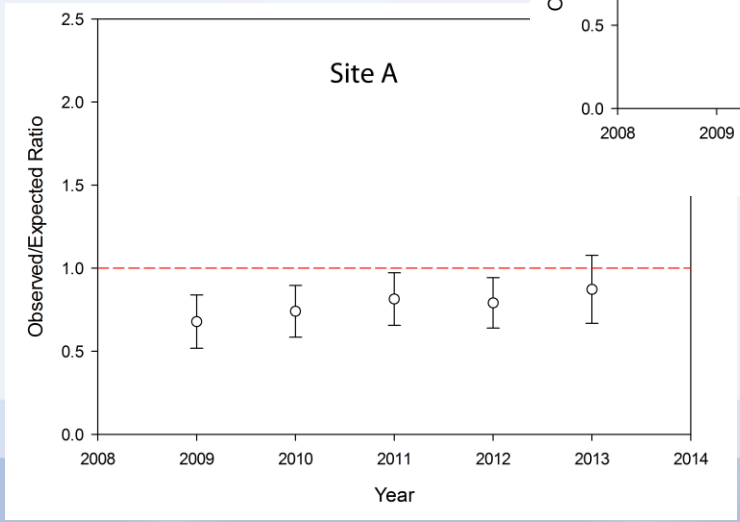
Observed / Expected Ratio: All Years



Observed / Expected Ratio: Sites By Year







OCEANS: Statistical Methods Library

Statistic	.NET Version	Java Version
Data Diagnostics		
Descriptive Statistics	X	X
Multi-collinearity diagnostics	X	X
Missing Data Management		
Simple Imputation	X	X
Automated Variable Selection Techniques		
Hierarchical Agglomerative Clustering	X	In Progress
Lasso (L1), Ridge (L2), and Elastic Net (L1-L2) Regression	X	In Progress
Risk Adjustment Methods		
Linear Regression	X	X
Logistic Regression	X	X
Propensity Score Matching	X	X
Sequential Comparative Effectiveness Analytics		
Risk Adjusted Sequential Probability Ratio Testing	X	X
Maximized Sequential Probability Ratio Tests	X	
Regression-Adjusted Proportional Difference Analysis	X	X
Bayesian Logistic Regression	X	X
Risk Adjusted Survival Analysis	In Progress	
Risk- & Learning Curve- Adjusted Sequential Analysis	In Progress	

Source: http://sourceforge.net/projects/oceans/ & http://www.idash.ucsd.edu

DELTA Study Dashboard

DELTA3 [ver. 1.071] Boston Advanced Analytics Inc.

DELTA3 Menu ▾ OCEANS csoadmin ▾

Studies

Step 1: Add Study | Step 2: Edit Study ▾ | Step 3: Run Study ▾ | Start Monitor | Refresh | Export to CSV | Grid Filter: Enter value to search... Filter Clear

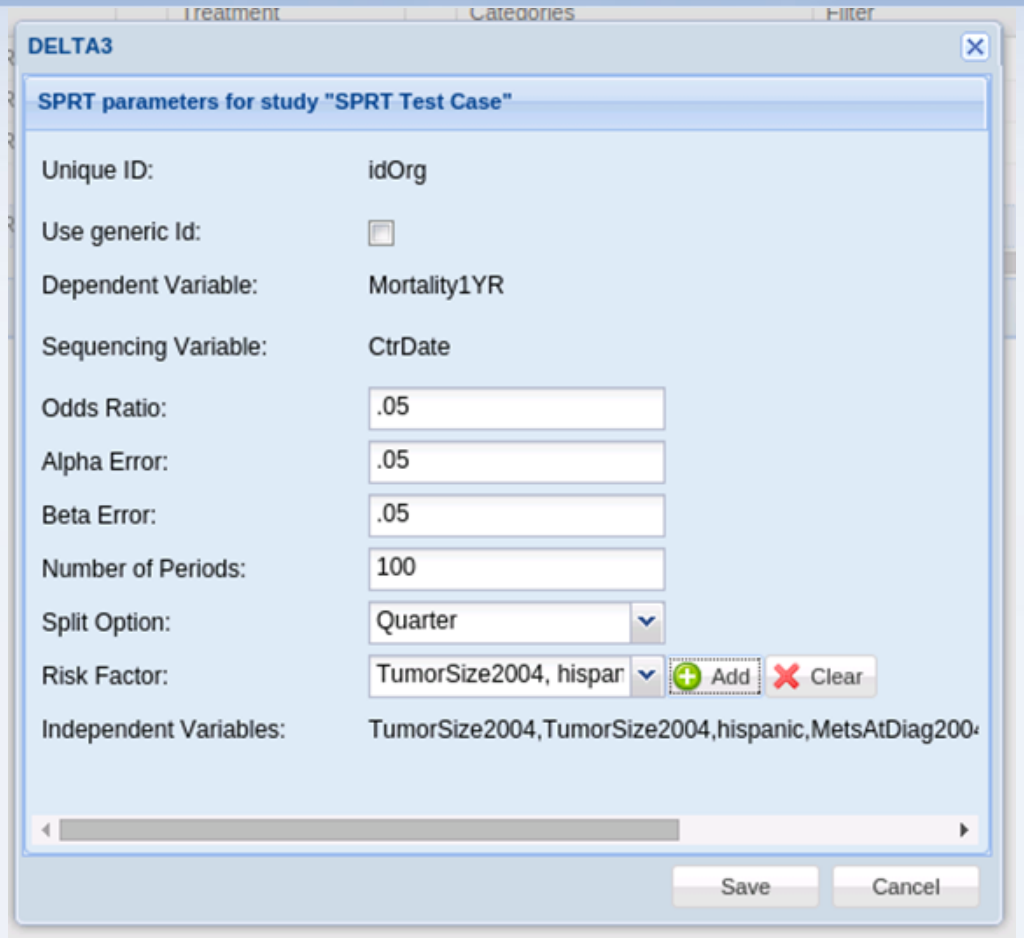
ID	Name	Description	Data Model	Start	End	Processed on	CI Primary	CI Secondary	Stage Status	Analysis Method	Outcome	Treatment
55	AFIB Clone	VA test	AFIB_STEP7_1	01/01/2009	12/31/2011	2014-11-07 13:52:15.0	95		P1 pending		MajorBleedingOutc...	Aspirin
62	DONT USE SE...	Dax Baseline LogR T...	SEER3 import	01/01/2000	12/31/2010	2015-01-27 01:04:32.0	95	95	PA1 pending	propensityScoreAnal...	Mortality1YR	TreatRadiation
28	Ext4	study description2	RM1	07/01/2008	09/30/2008	2015-01-27 01:05:20.0	99	95	LR2 completed	logisticRegression	PostBleed	CathTreatment
51	Ext4 Clone	study description2	RM1	09/10/2007	09/10/2008	2014-10-23 14:14:41.0	95		LR1 completed		PostBleed	PCI2
65	Mareks SEER3...	cloned from seer3 im...	SEER3 import	04/01/2000	12/31/2010	2015-03-07 22:38:49.0	98	95	LR 1 of 2 In Progress	logisticRegression	Mortality1YR	TreatRadiation
58	SEER3	for ver. 1.01	SEER3 import	01/01/2000	12/31/2010	2015-03-08 20:12:08.0	95	95	PA Completed	propensityScoreAnal...	Mortality1YR	TreatRadiation
63	SEER3 Baselin...	Dax Baseline LogR	SEER3 import	04/01/2008	12/31/2010	2015-02-23 15:19:21.0	98	95	New	logisticRegression	Mortality1YR	TreatRadiation
61	SEER3 Baselin...	Dax Baseline PA Tes...	SEER3 import	01/01/2000	12/31/2010	2015-03-05 16:59:23.0	95	95	PA Completed	propensityScoreAnal...	Mortality1YR	TreatRadiation
67	SEER3 DAX LR	LR Dax Experiement	SEER3 import	01/01/2007	01/01/2015	2015-03-05 16:49:35.0	95	95	LR Completed	logisticRegression	Mortality1YR	TreatRadiation
59	SEER3 LR	seer3 imp LR	SEER3 import	04/01/2008	12/31/2010	2015-03-05 14:27:31.0	98	95	LR Stage 2 of 2 Re...	logisticRegression	Mortality1YR	TreatRadiation
64	SEER3 SPRT	based on Michael's d...	SEER3 import	01/01/2000	12/31/2010	2015-04-06 13:27:20.0	95	95	SPRT 1 of 1 In Pro...	riskAdjustedSPRT	Mortality1YR	TreatRadiation
57	SeerDemo2	based on Michael's d...	SEER2	01/01/2000	01/01/2014	2015-01-27 01:05:11.0	95	95	P1 pending	propensityScoreAnal...	Mortality1YR	TreatRadiation

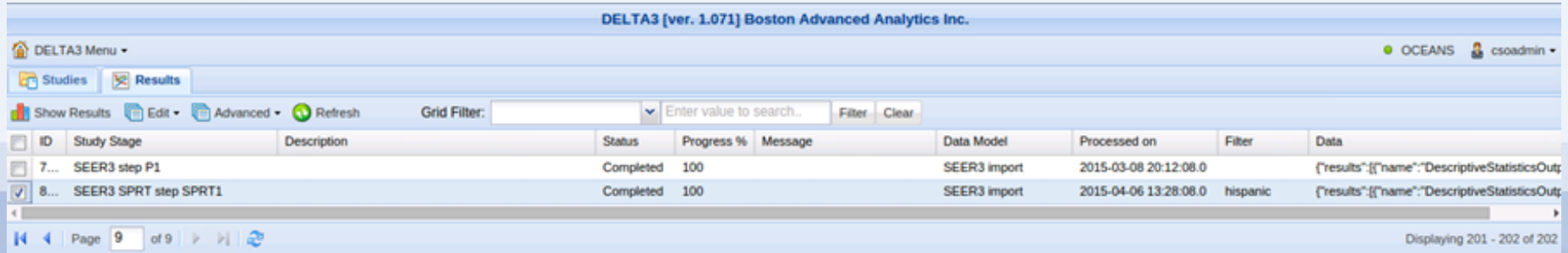
Page 1 of 1 Displaying 1 - 12 of 12

BOSTON Advanced Analytics
Advanced Software for Enhanced Healthcare

Powered By OCEANS

Study Configuration & Results Management

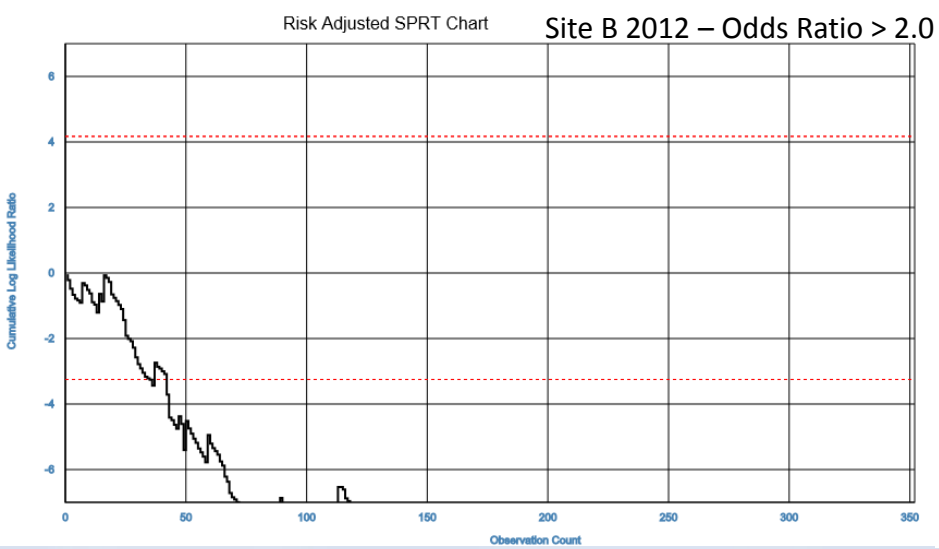


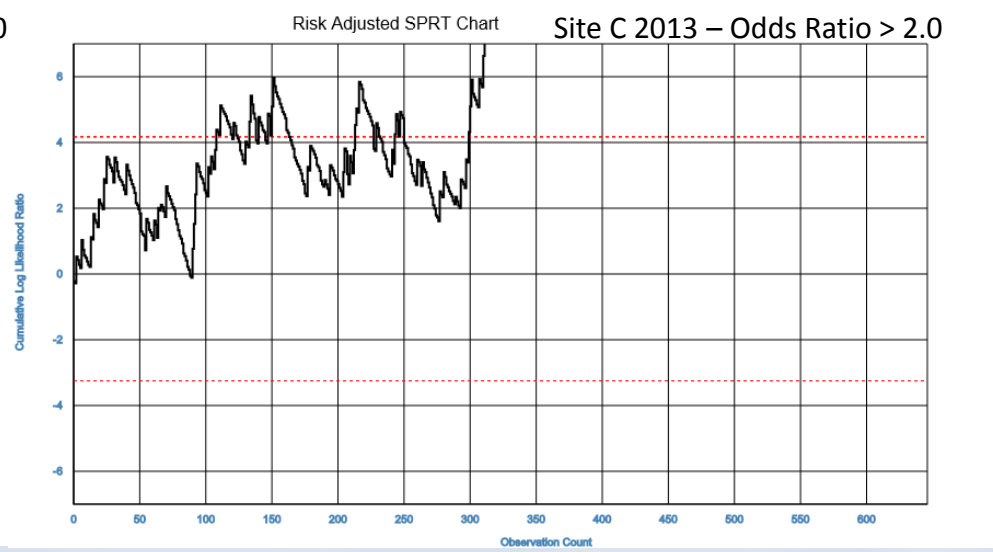


DELTA RA-SPRT Simulated Prospective Study Results

- Number of Centers detected as an outlier by number of calendar years of outlier status:

Test	1	2	3	4	5
Odds Ratio > 2.0	8	8	2	2	1
Odds Ratio < 0.5	21	7	4	2	0





Conclusions

- There is wide variation in institutional AKI event rates, suggesting that understanding and reducing practice variation could improve AKI rates nationally
- There were clear high and low outliers that are candidates for chart review and root cause analysis to determine practice variation causes
- The surveillance tool performs adequately using the underlying statistics modules and graphing packages, and can support other outcomes and exposures

Overall Summary

Conclusions

- Real Time NLP is feasible and scalable to national VA volume for specific domains
- Post-procedural AKI prediction is moderately to highly accurate, depending on the outcome used
- Wide variation in institutional AKI event rates
- Big questions that remain for this work:
  - whether the NLP variables will improve risk-adjustment for variation detection?
  - What are the primary drivers of risk-adjusted institutional variation?

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FDA SOL-08-00837A (Resnic)

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  - Wendy Chapman

For more information contact:

michael.matheny@va.gov

michael.matheny@vanderbilt.edu