

Predictive Modeling for Health Systems

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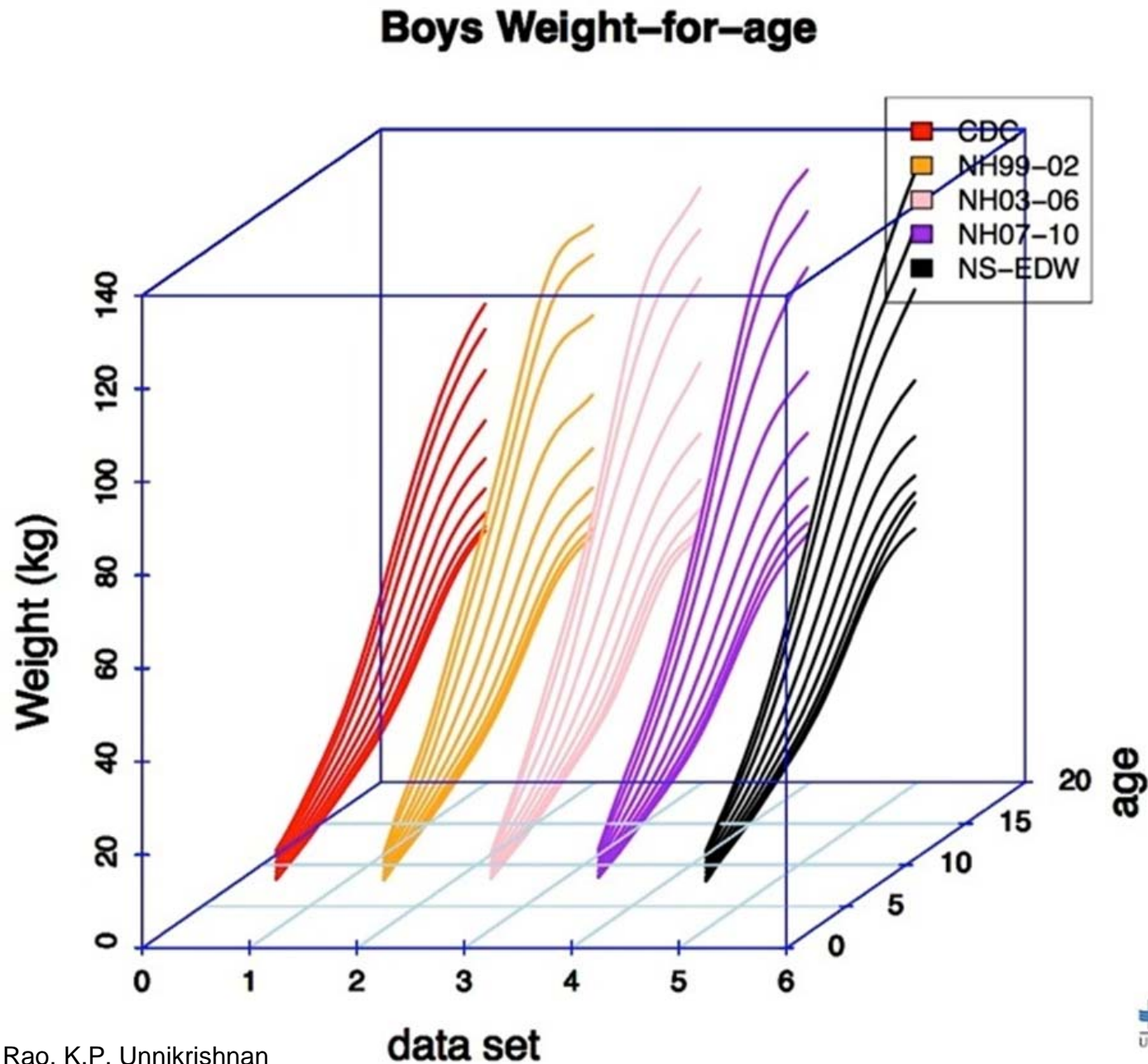
Performance and Scale of EMR/Data at NorthShore University HealthSystem

- 2003 First Epic Inpatient Deployment (enterprise)
 - Epic instance across 4 Hospitals, 50 offices, ~2000 Docs
 - Over 4M Total healthcare visits / year and growing fast
- 2009 First in the U.S. awarded by HIMSS Analytics the top level (Stage 7) of inpatient clinical system use
- 2010 Enterprise Data Warehouse (EDW) from many systems ~2M patients in ~5TB of transactions/indexes
- 2011 Only Round 1 Meaningful Use In and Out-Patient
- 2011 Center for Biomedical Research Informatics
- 2013 First health system awarded by HIMSS Analytics the top level (Stage 7) of outpatient clinical system use
 - Many, many awards for IT, Admin, Informatics teams

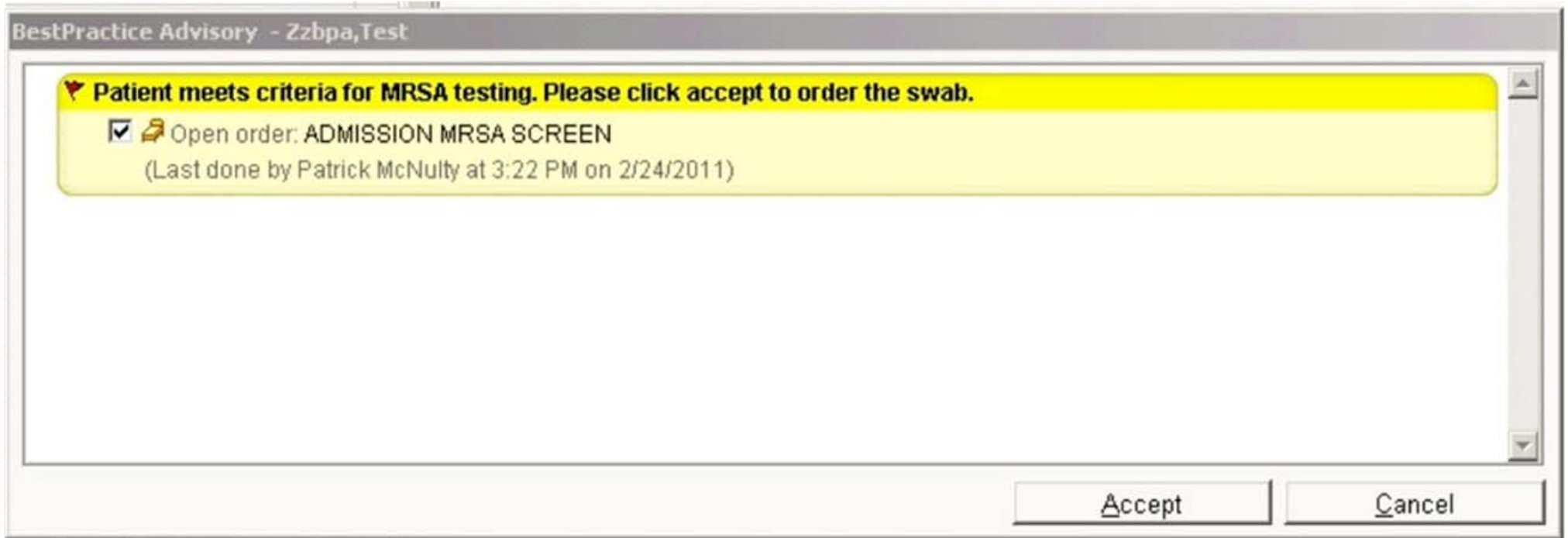
Informatics Creates Opportunities at Scale (toward standardization at lower cost)

- Surveillance Algorithms
 - System monitors and recommends specific intervention for patients who meet known criteria.
- Predictive Algorithms
 - System recommends specific intervention for patients by analyzing thousands of similar patients' data.
- Collection of Discrete Clinical Data
 - System collects data in context-specific EHR workflows for research and quality improvement.
- Integration of EMR/EDW & External Systems
 - System exchanges data and extends workflow.

Mining, prediction and validation at scale



Risk-based testing for MRSA

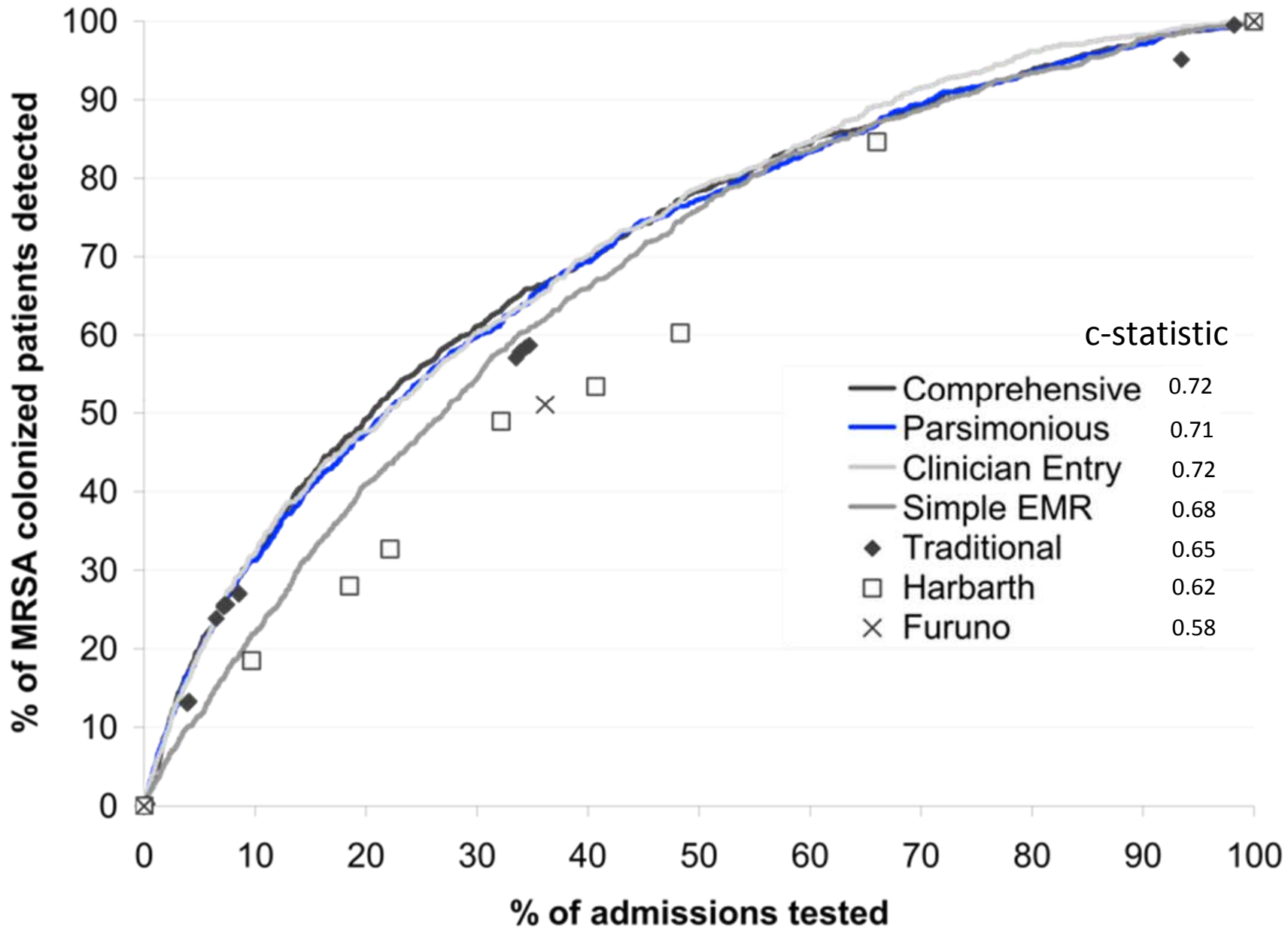


Parsimonious model:

$$LO = -4.620$$

- + 0.083 × (age/10)
- + 0.138 (if male)
- + 0.426 (if black or African American^a)
- − 0.223 (if other nonwhite race^a)
- + 1.016 (if nursing home resident)
- + 0.300 (if admission service^b = internal medicine)
- + 0.414 (if admission service^b = psychiatry)
- − 0.249 (if admission service^b = surgery)
- + 0.865 (if feeding tube at admission)
- + 0.712 (if pressure ulcer at admission)
- + 0.276 (if microbiologic test performed at admission or in prior week)
- + 0.506 (if skin or bone infection at admission)
- + 0.406 (if hemoglobin level <8.6)
- − 1.382 (if cephalosporins in previous month)
- + 0.309 (if other antimicrobials in previous month)
- + 2.178 (if cystic fibrosis)
- + 0.344 (if heart disease)
- + 0.487 (if lung disease)

MRSA detection performance comparison: 7 prediction rules



Meets pretest probability threshold for testing; has not been tested yet

Meets pretest probability threshold for testing; has been tested already

Does not meet pretest probability threshold for testing

Calculation of pretest probability for patient "Vte3, Testrun"

MRSA Screening - GB Hospital (56 Patients)

as of 1339

| Unit | Patient Name/Age/Sex | Actual Length of Stay (Days) | MRSA Screen Score | MRSA Swab Needed | Isolation | MRSA Infection Dx |
|-------------------|----------------------|------------------------------|-------------------|------------------|-----------|-------------------|
| GB ICU | Vte3, T (60YO M) | 135 | 2.251 | | | |
| GB ICU | Vte1, T (60YO M) | 140 | 1.501 | | | |
| GB 3 EAST | Grach, T (49YO M) | 183 | 1.3077 | | CONTACT | Yes |
| GB EMERGENCY ROOM | Muhosp, E (77YO F) | 163 | 1.0651 | | | |
| GB 3 NORTH | Hdmt, A (94YO M) | 210 | 0.9182 | | | |
| GB 3 NORTH | Rtwotenu, G (91YO M) | 6 | 0.8933 | | | |
| GB EMERGENCY ROOM | Mu, S (34YO M) | 162 | 0.7642 | | AIRBORNI | |

ECR IP MRSA SCREENING | ENH NURSING KARDEX | Report: ECR IP MRSA SCREENING

Vte3, Testrun MRN#205054778 (Encounter#: 34992547) (60YO M) GICU-0100-10 (Adm: 11/16/10)

Attending Provider: Mandal, Ronnie, DO

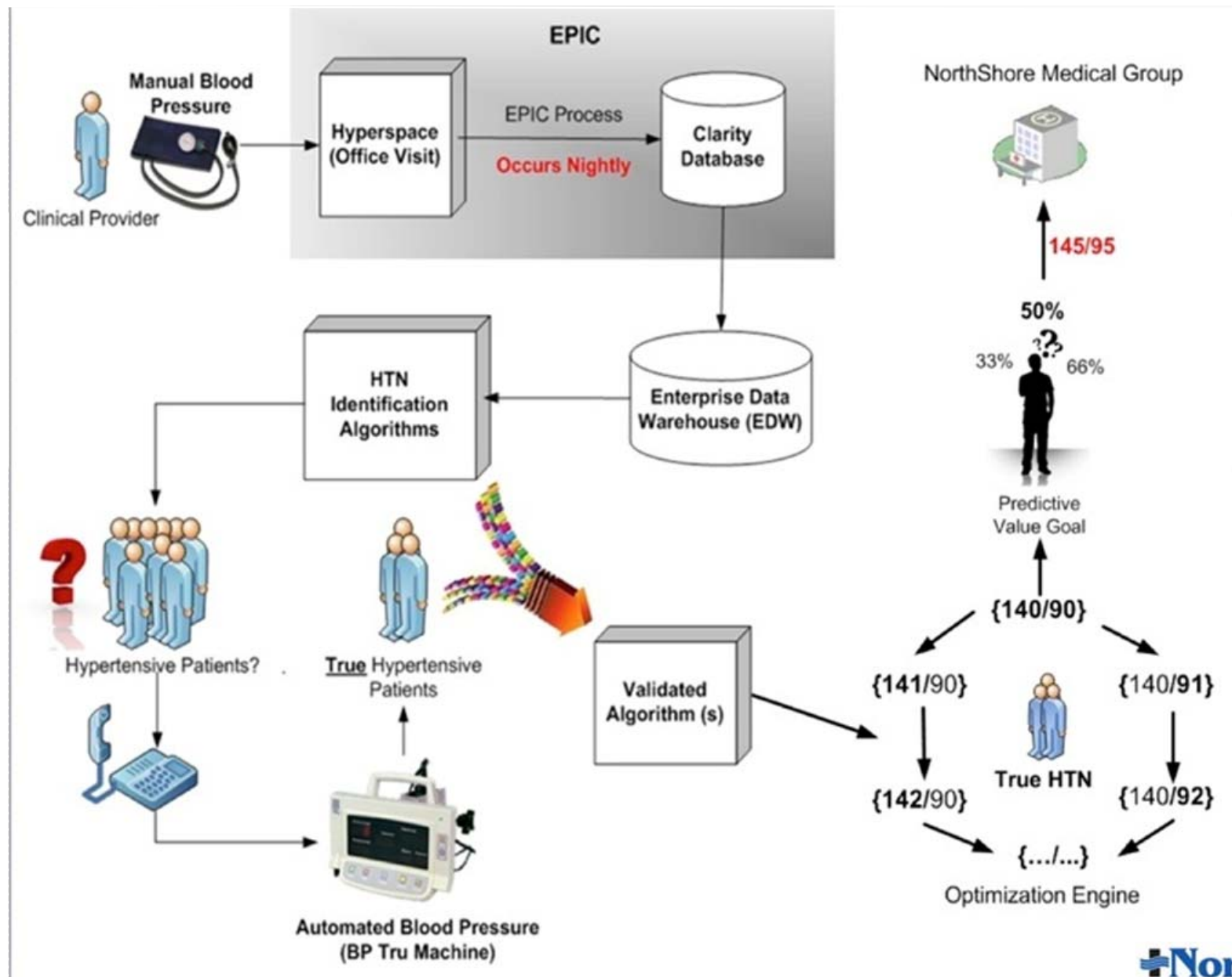
Allergies: **No Known Allergies** | Isolation: None | HT: -- | Anticipated Dx: (none) | BMI: --
Code Status: Not on File | WT: -- | BSA: --

MRSA SCREENING PATIENT SCORING : 2.251

- MRSA Age: 0.498 points (Up 0.498 points since last review) - [Last updated: 03/31/11 1341]
- Patient Sex: 0.138 points (Up 0.138 points since last review) - [Last updated: 03/31/11 1341]
- Tube Feeding Order or Documentation: 0.865 points (Up 0.865 points since last review) - [Last updated: 03/31/11 1341]
- Pressure ulcer present on admission: 0.75 points (Up 0.75 points since last review) - [Last updated: 03/31/11 1341]

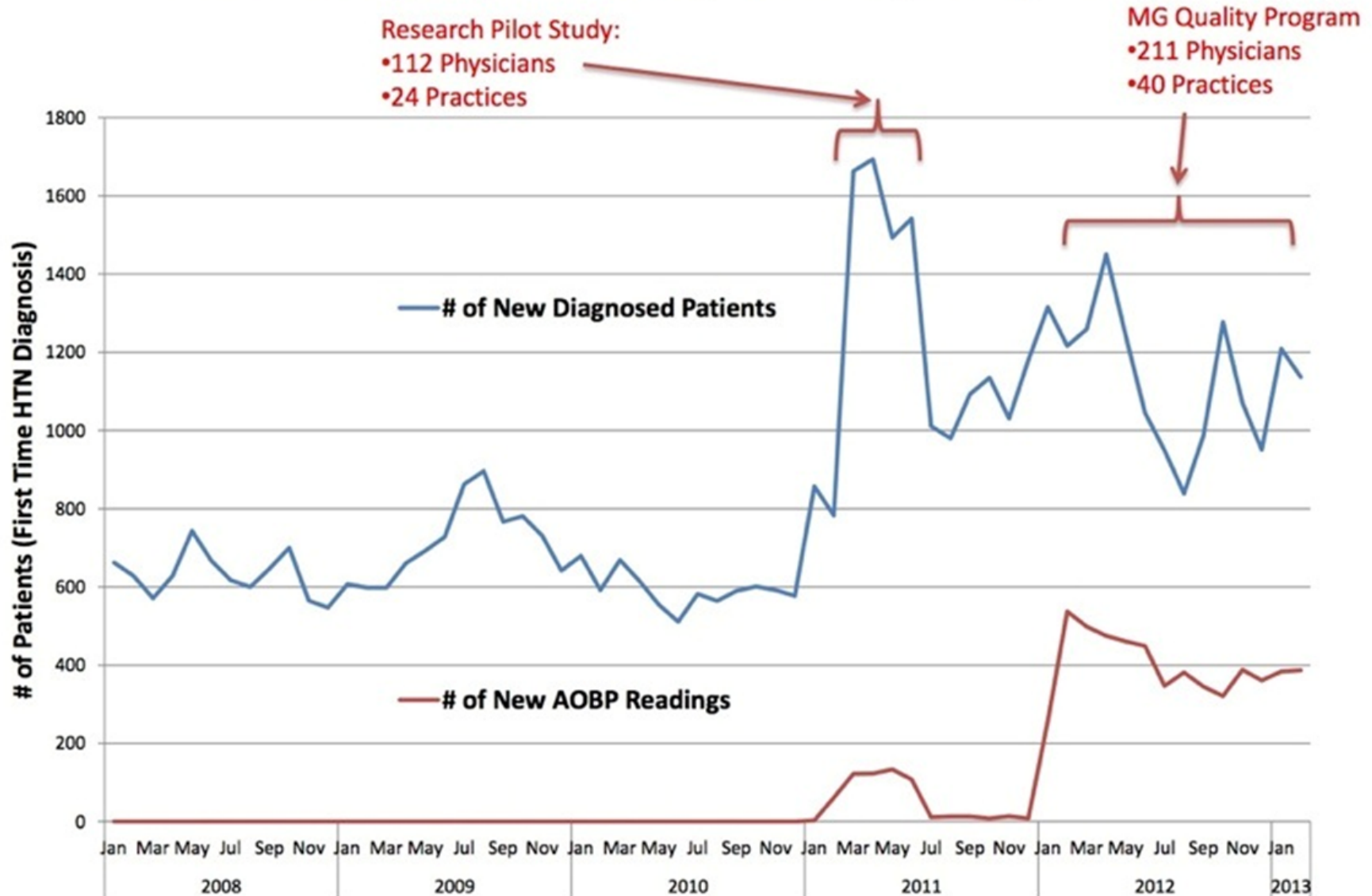
All Microbiology Results

Eliminating Undiagnosed HTN 2010-2012



Eliminating Undiagnosed HTN 2010-2012

Patients Newly Diagnosed with Hypertension by Primary Care

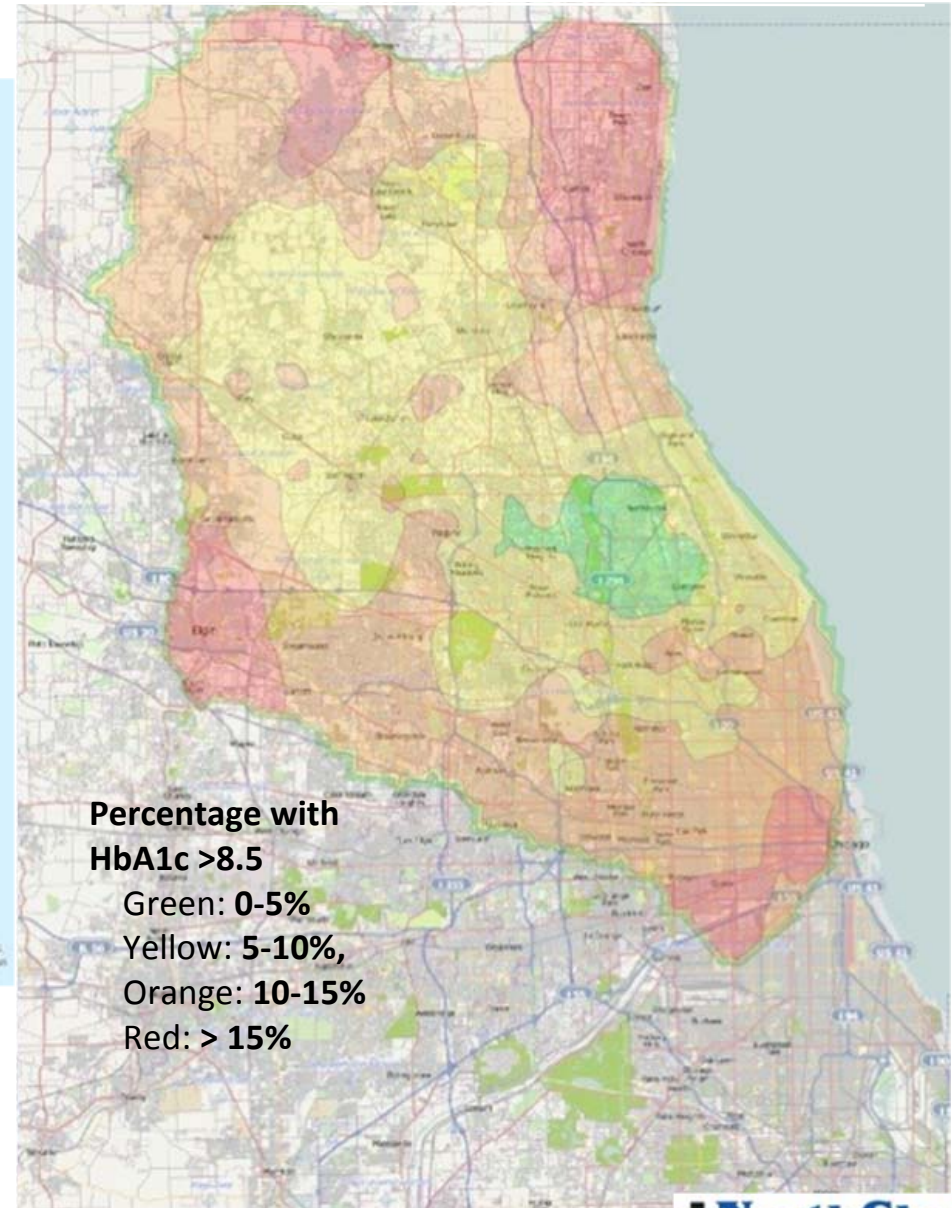
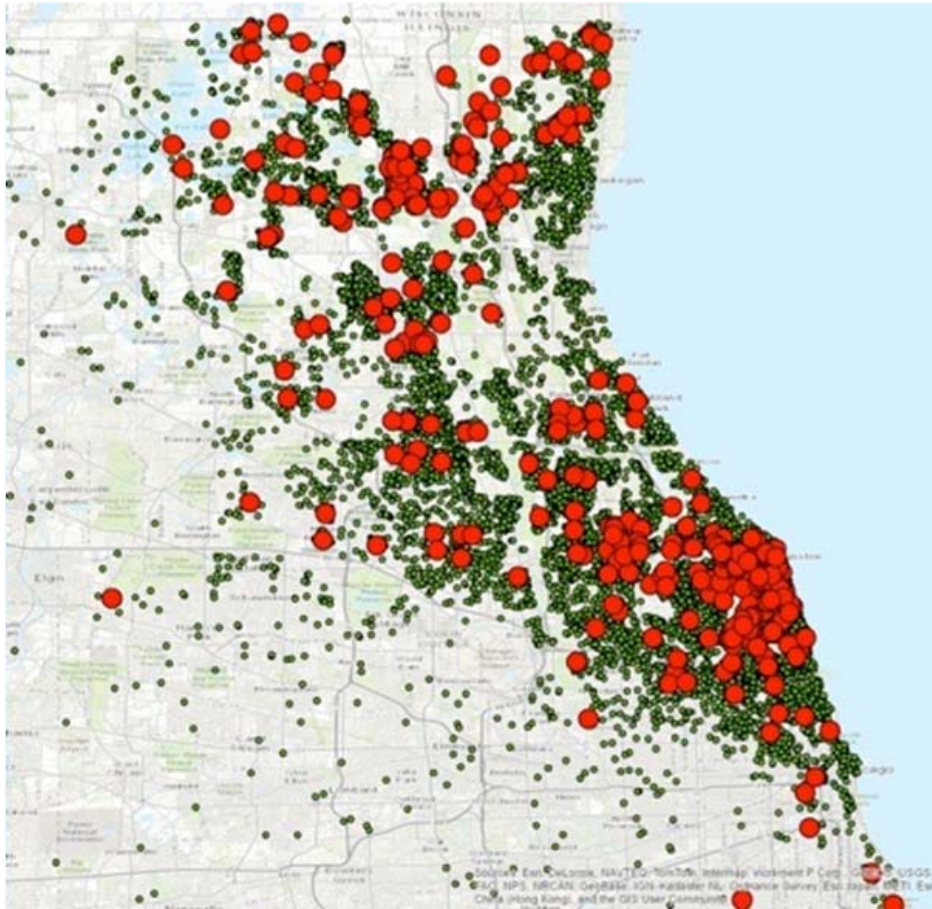


30-day readmission prediction

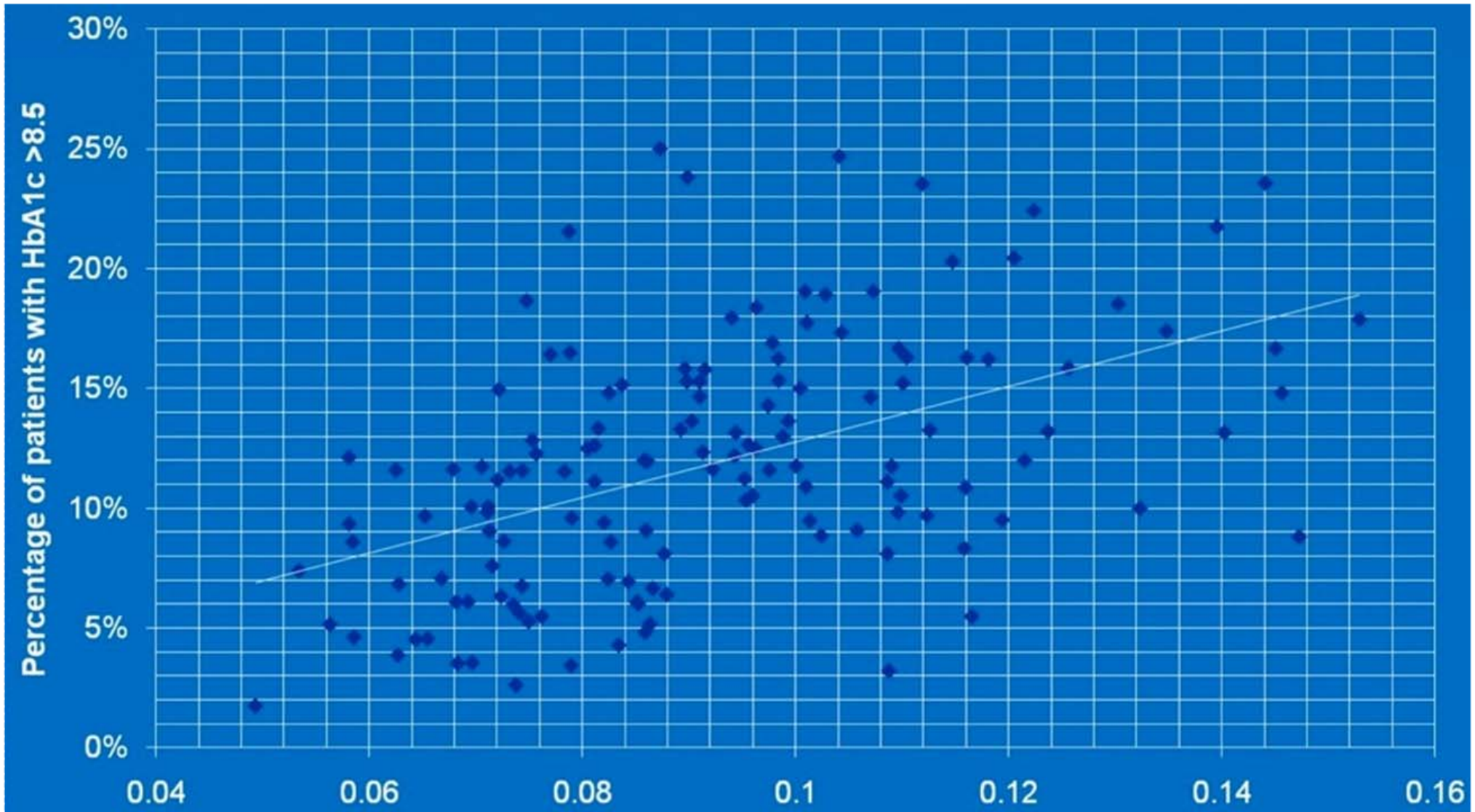
- 35 variables identified by local experts as likely predictive of readmissions
- Parsimonious model from 18,498 patients
- C-statistic: 0.68
- Pilot reports on 4 nursing units Jan 6 - Feb 12 2012
- Validation

| Risk Group | Number of Patients | % Readmitted in 30 Days |
|------------|--------------------|-------------------------|
| High | 175 | 33% |
| Medium | 141 | 16% |
| Low | 632 | 12% |

Geocoding for Syndromic Surveillance



% of patients with HbA1c > 8.5 and median risk in a physician's panel (>19 each PCP)



Characteristics of an ideal documentation system

- Supports and encourages consistent and complete documentation of discrete data
- Accommodates clinician expressivity (emulating it when possible)
- Accommodates clinical workflows
- Can be developed quickly on a large scale

| | Workflow unchanged | Implementation Cost |
|---------------------|--|--|
| Consistent/Complete | | Prospective discretization encourages consistent and complete documentation, but may constrain expressivity and require changes to workflows. |
| Expressive | Retrospective discretization accommodates expressivity and existing workflows, but may have to contend with incomplete or inconsistent documentation. | |

Clinical Workflow Discrete Data-Entry Tools

Medical History

Medical Conditions

| | | | |
|-----------------------|-----|----|-------|
| Diabetes | Yes | No | Hep: |
| Asthma | Yes | No | Emp: |
| Acute Pancreatitis | Yes | No | Chrc: |
| Hypertension | Yes | No | Corc: |
| Myocardial Infarction | Yes | No | CVA: |
| Clotting disorder | Yes | No | Can: |

History Navigators

SmartForms

Prostate Exam

Prostate

Left Seminal Vesicle

palpable

Left Base

redistribution

Left Mid

redistribution

Left Apex

redistribution

Prostate Exam: Prostate is enlarged and tender.

SmartForms

Doc Flowsheets

9-HPT - 9-Hole Peg Test

Encounter: Office Visit from 11/5/2012 in NEURO GB ACC
Date: 11/05/12

9-Hole Peg Test

Dominant Hand: Right Left

Dominant Hand - Trial 1

Time (seconds)

For a complete trial, record any circumstances

If trial was not completed (mark)

Doc Flowsheets

Questionnaires

Current Questionnaires

COUGH/COLDS/FLU QUESTIONNAIRE

| Adv | Question | Answer |
|-----|--------------------------------------|--------|
| | How long have you had your symptoms? | |
| | Have you had a fever? | |
| | What Temperature: | |
| | Shaking chills? | |

Questionnaires

Results Console

CBC with Differential

| | |
|------------|-------|
| WBC | Order |
| RBC (CBC) | Order |
| Hemoglobin | Order |
| HCT | Order |
| MLV | Order |
| MCH | Order |
| MCHC | Order |

Results Console



Enhanced procedure notes

Complications Manager

NEEDED FOR USE WITH SURGICAL COMPLICATIONS (problems related to a Surgery episode of Care)

| Intervention Action | Start Date | Stop Date | Comment |
|-----------------------------|------------|-----------|---------|
| 1 (RCP without chest drain) | 7/24/12 | 7/24/12 | |
| 2 | | | |

Complications Manager

Structured Clinical Documentation System (SCDS) Projects

- Current

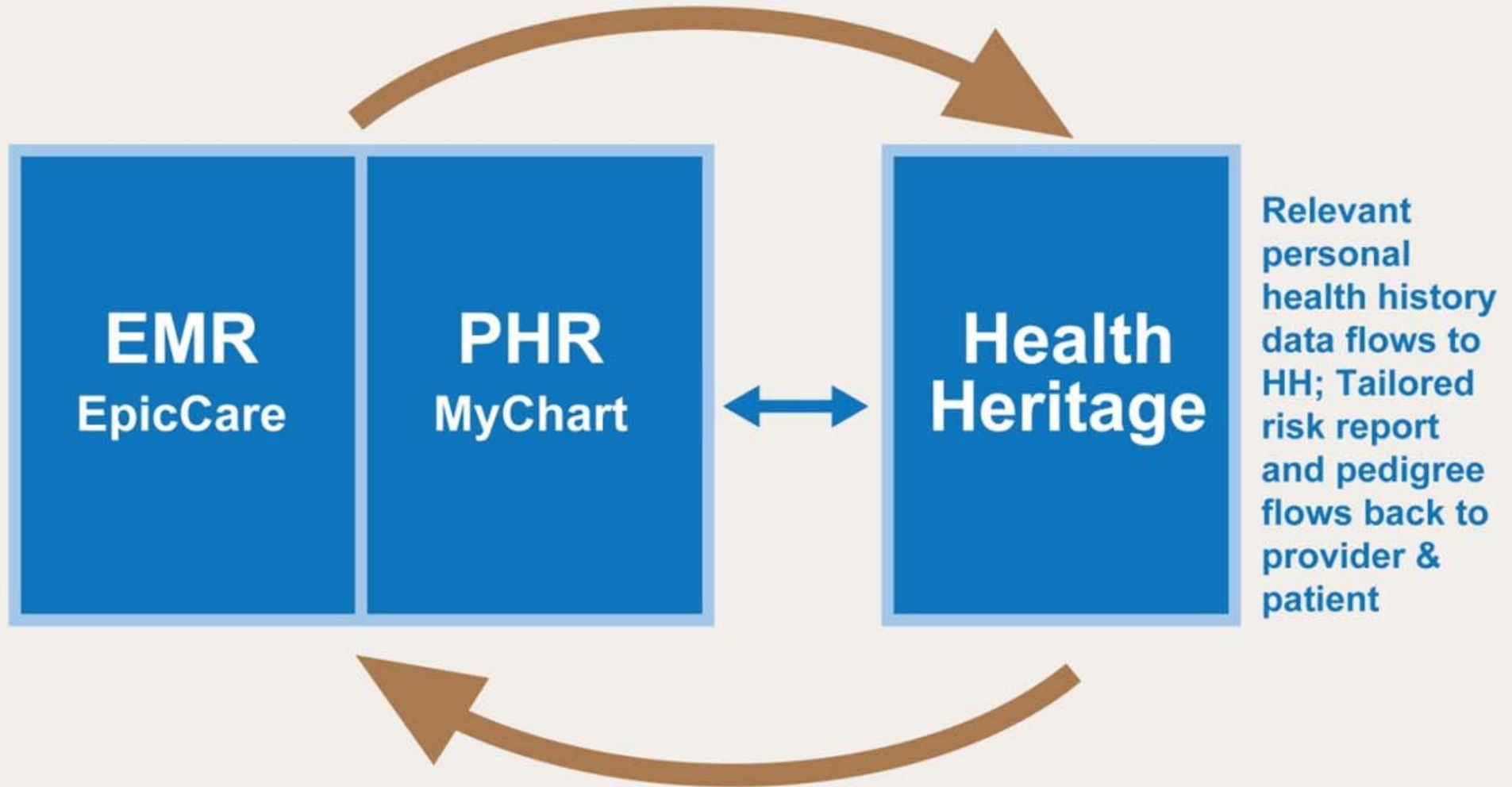
- Parkinson's Disease
- Pancreatic Cancer Surgery
- Pelvic Prolapse
- Colorectal Cancer
- Prostate Cancer
- Migraine
- Hysterectomy for benign indications
- Multiple Sclerosis
- Sleep
- Diabetes
- Lung Cancer

- Coming Soon

- CHF
- Epilepsy
- Alzheimer and Memory
- Neuro - Oncology
- Stroke
- Neurophysiology
- Total Knee Replacement
- Spine
- Thyroid
- Ophthalmology
- Mild Traumatic Brain Injury

INFORMATION FLOW BETWEEN AN ELECTRONIC MEDICAL RECORD, PERSONAL HEALTH RECORD AND HEALTH HERITAGE

Medical, Surgical, Family History, Labs



Risk Results, Recommendations & Pedigree