Analytics Track
AMDIS 2014

Moderated by Christopher Longhurst, MD, MS
VP of Analytics and Informatics
Stanford Children’s Health
Enable effective and efficient decision making through user-friendly access to quality information.
The Gamut of Analytics

• Population health management
  Dick Gibson, MD, PhD

• Data Exploration at MetroHealth
  David Kaelber, MD, PhD

• Innovation and localization of data analytics at VA
  Sarah Russell, MD, MBA

• Text and waveform (big data) analytics at Stanford Children’s
  Jon Palma, MD, MS and Veena Goel, MD

• Complex event processing
  Sameer Badlani, MD

• Panel Q&A – 30 mins
  All
Information Technology for Population Health Management

The Physician Computer Connection

AMDIS – Ojai

Thursday, 19 June 2014

Dick Gibson MD PhD

Portland OR
Overall Organizational Strategy

Clinical and Business Strategy for ACO

Functions Needed for a Successful ACO

Determine Timeline of Need for Each Function

Examine Specific Vendor Products

Budget and Roadmap

Use Existing Systems

Buy New Systems

Introduce Systems into Learning Organization
Major Functions of Population Health Management

- Provider Record of Care
- Patient & Family-facing Functions
- Attribution
- Risk Identification
- Group Tracking
- Care Planning
- Care Management
- Patient Outreach
- Performance Reporting
- Financial Management
Provider Record of Care

- Each professional has system to record useful information about the encounter, evaluation, or action taken
- Each professional can see the records of the other professionals either by viewing or importing (say with HIE)

Patient & Family-facing Functions

- Allows patient & family to enter their own data and respond to surveys
- Includes outcome analytics of value for the patient & family
- Includes report cards on providers and facilities
- Assists patient and family decision-making
Attribution of Patients to Providers

- Algorithm options: based on number of visits with primary care, most recent visit, intensity, total payments, CMS attrib
- Algorithms are transparent to providers

Risk Identification

- Which patients are most likely to get ill?
- Which patients would benefit most from intervention?
- What intervention is indicated?
- Will that intervention make a difference in outcome?
Group Tracking

- Identify patients by age, diagnosis, procedure, medication, labs, habits, health risk assessment, preventive care
- Updated promptly by action charted in EHR
- Single-patient report is viewable within EHR visit workflow
- Multi-patient reports are easily accessible

Care Planning

- The clinical content of Care Management
- For a given indicator/diagnosis, what is indicated to be done?
- Which providers need to do what by when?
- What does a given provider need to do today at the office visit
Care Management

- EVERY patient gets it
- may be done intermittently
- results in a single approved care plan
- done by clinical personnel
- same as Care Coordination

Case Management

- only SOME patients get it
- provided continuously
- assists with coordination of services
- assists with daily living skills
- assists with finding & maintaining housing, jobs, friends
- may provide transportation
- done by professionals and paraprofessionals

http://www.tacinc.org/media/13119/Managed%20Care.pdf
Care Management

- Organized by Care Goals and Long-term Care Plan
- Imports data from and sends data to Provider Record of Care
- Captures charting by Care Managers and Case Managers
- Uses the clinical content of the Care Planning system

Patient Outreach

- Manual selection of patients
- Automatic patient selection based on Group Tracking
- Manual deselection when contact would be inappropriate
- Library of campaign messages based on condition
Performance Reporting

- Patient clinical and financial outcomes by provider
- Provider productivity
- Identify providers to be coached, join, or leave network
- Ability to compare performance to benchmarks

Financial Management

- Cost of care analysis
- Analysis to negotiate contracts with providers and payers
- Out of network costs
- Benefit design and premium calculation
The Functions Overlap

- Patient/Family Facing
- Risk Identification
- Group Tracking
- Care Planning
- Care Management
- Provider Record
- Patient Outreach

Performance Reporting
Financial Management
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<th>Emp or payer survey</th>
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<th>Lab company</th>
<th>Public health or the state</th>
<th>CMS (MEDPAR)</th>
<th>Employer files</th>
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Year 1

Year 2

Year 3
Questions?

Information Technology for Population Health Management

The Physician Computer Connection

AMDIS – Ojai

Thursday, 19 June 2014

Dick Gibson MD PhD

Portland OR
Data Exploration @ MetroHealth
(3 cases)

David C Kaelber, MD, PhD, MPH, FAAP, FACP

Board Certified in Clinical Informatics
Associate Professor of Internal Medicine, Pediatrics, Epidemiology, and Biostatistics
Director of the Center for Clinical Informatics Research and Education
Chief Medical Informatics Officer
The MetroHealth System
Case Western Reserve University
MetroHealth and EHR (Epic)

System Overview
• 1 tertiary care academic hospital
• 21 outpatient facilities
• 300+ resident/fellow physicians
• 500 staff physicians
• 1,200 nurses
• 30,000 inpatient stays/year
• 100,000 ED visits/year
• 1,000,000 outpatient visits/yr
• Affiliated with Case Western Reserve University
• Public healthcare system for Cuyahoga County

Total EHR data
• 1 million patients
• 15 million visits
• 120 million labs/pathology
• 750,000 imaging studies
• 15 years of data in Epic

• 1999 - Ambulatory EHR (EpicCare w/ Cadence, Prelude, & Resolute)
• 2004 - EHR in ED (ASAP)
• 2009 - Inpatient EHR (Epic w/ Inpatient Willow and Beacon)
• 2011 - CareEverywhere, e-Rx, MyChart, Nurse Triage
• 2012 - Epic Enterprise Contract, MU Stage 1
• 2013 - BCMA, EpicCare Link, Welcome
• 2014 - ADT, Bedtime, OpTime, SBO, Research

1st public healthcare system in US to install Epic in the outpatient setting!!!
1st public healthcare system in US with Epic to achieve HIMSS Stage 7 EMRAM Ambulatory (5/14)!!!
Case #1 - Pediatric Hypertension
## Case #1 - Pediatric Hypertension

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<th>Blood Pressure</th>
<th>Adult</th>
<th>Children</th>
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<td>Normal</td>
<td>SBP ≤120 and/or DBP ≤80</td>
<td>SBP and/or DBP &lt; 90% for gender, age, and height</td>
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<tr>
<td>Pre-hypertensive</td>
<td>SBP &gt;120 and ≤139 and/or DBP &gt;80 and ≤89</td>
<td>SBP and/or DBP ≥ 90% and &lt; 95% for gender, age, and height</td>
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<tr>
<td>Stage I HTN</td>
<td>SBP &gt;139 and ≤159 and/or DBP &gt;89 and ≤99</td>
<td>SBP and/or DBP ≥ 95% and ≤ 99% +5mmHg for gender, age, and height</td>
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<tr>
<td>Stage II HTN</td>
<td>SBP &gt;159 and/or DBP &gt;99</td>
<td>SBP and/or DBP &gt; 99% +5mmHg for gender, age, and height</td>
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</table>

Need 3 measurements for diagnosis of hypertension (HTN) or prehypertension (preHTN).
Case #1 - Pediatric Hypertension

“It’s like you discovered the Post-It® note!”

AHA Top 10 Research Advance of 2007!
*Ladies’ Home Journal* Healthcare Breakthrough Award of 2008!
Case #2 - Referral Completion

“The MetroHealth System is not reaching its financial revenue targets because expected patient volumes are down in both primary care and specialty care.”

- MetroHealth CEO (summer 2011)
Case #2 - Referral Completion

Consults/procedure orders written yesterday not completed or scheduled today.

After 12 months (2/2012-2/2013) the 30-day consult and procedure completion/schedule rate went from 48% to:

Answer: 61%

~6700/month additional initial consults (61,939) and procedures (18,936) completed/scheduled (and ~$1,000,000/month in new gross revenue).
Case #3 – “Big Data”
Case #3 – “Big Data”

- Pooled, normalized, standardized EHR data
- Over 40 million patients (6/17/2014; growing)
- Web interface (Google-like speed)
- Data Types
  - Demographic (gender, age, race/ethnicity, insurance, zip-3)
  - Diagnoses (ICD-9, SNOMED-CT)

Unified Medical Language System (UMLS)

Example – Post-market drug surveillance of Azathioprine (relatively rarely used drug with rare side effect); are side effects more/less or the equivalent to similar drugs
# Case #3 – “Big Data”

## Side Effects Investigated

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<th>Lab Value</th>
<th>Abnormal Range</th>
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<td>Hemoglobin (Hgb)</td>
<td>&lt;11 g/dL</td>
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<td><strong>Cell lysis</strong></td>
<td>Lactate dehydrogenase (LDH)</td>
<td>&gt;190 IU/L</td>
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<td><strong>Fever</strong></td>
<td>Temperature</td>
<td>&gt;37.8°F</td>
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<td><strong>Hepatotoxicity</strong></td>
<td>AST, ALT</td>
<td>AST&gt;40 IU/L and ALT&gt;40 IU/L</td>
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<td>Total bilirubin (Bili)</td>
<td>&gt;1 mg/dL</td>
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<td><strong>Hypertension</strong></td>
<td>Blood pressure (BP)</td>
<td>Systolic &gt;140 mm Hg or Diastolic&gt;90 mm Hg</td>
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<td><strong>Nephrotoxicity</strong></td>
<td>Creatinine (Cr)</td>
<td>&gt;1.5 mg/dL</td>
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<td><strong>Neutropenia</strong></td>
<td>Neutrophil count</td>
<td>Count&lt;57% or &lt;2.5 cells/µl</td>
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<td>Neutrophil count</td>
<td>Count&gt;70%</td>
</tr>
</tbody>
</table>
Case #3 – “Big Data”

Side Effects Investigated

<table>
<thead>
<tr>
<th>Side Effect</th>
<th>Lab Value</th>
<th>Abnormal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anemia</td>
<td>Hemoglobin (Hgb)</td>
<td>&lt;11 g/dL</td>
</tr>
<tr>
<td>Cell lysis</td>
<td>Lactate dehydrogenase (LDH)</td>
<td>&gt;190 IU/L</td>
</tr>
<tr>
<td>Fever</td>
<td>Temperature</td>
<td>&gt;37.8°F</td>
</tr>
<tr>
<td>Hepatotoxicity</td>
<td>AST, ALT</td>
<td>AST&gt;40 IU/L and ALT&gt;40 IU/L</td>
</tr>
<tr>
<td>Hepatotoxicity</td>
<td>Total bilirubin (Bili)</td>
<td>&gt;1 mg/dL</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Blood pressure (BP)</td>
<td>Systolic &gt;140 mm Hg or Diastolic &gt;90 mm Hg</td>
</tr>
<tr>
<td>Nephrotoxicity</td>
<td>Creatinine (Cr)</td>
<td>&gt;1.5 mg/dL</td>
</tr>
<tr>
<td>Neutropenia</td>
<td>Neutrophil count</td>
<td>Count&lt;57% or &lt;2.5 cells/µl</td>
</tr>
<tr>
<td>Neutrophilia</td>
<td>Neutrophil count</td>
<td>Count&gt;70%</td>
</tr>
</tbody>
</table>
## Case #3 – “Big Data”

Control cohort administered one of 12 anti-rheumatic drugs. Overlap is evident between the cohorts since controlling the AZA cohort for the absence of the other 12 drug.

<table>
<thead>
<tr>
<th>Drug Name (RxCUI)</th>
<th>Control Cohort</th>
<th>AZA Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abatacept (614391)</td>
<td>140 (0.1%)</td>
<td>60 (0.4%)</td>
</tr>
<tr>
<td>Adalimumab (327361)</td>
<td>2660 (2.1%)</td>
<td>650 (4.7%)</td>
</tr>
<tr>
<td>Azathioprine (1256)</td>
<td>3610 (2.8%)</td>
<td>13890 (100.0%)</td>
</tr>
<tr>
<td>Clioquinol (5942)</td>
<td>110 (0.1%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Etanercept (214555)</td>
<td>2490 (1.9%)</td>
<td>250 (1.8%)</td>
</tr>
<tr>
<td>Homatropine (27084)</td>
<td>66170 (51.1%)</td>
<td>680 (4.9%)</td>
</tr>
<tr>
<td>Hydroxychloroquine (5521)</td>
<td>22900 (17.7%)</td>
<td>2000 (14.4%)</td>
</tr>
<tr>
<td>Infliximab (191831)</td>
<td>2880 (2.2%)</td>
<td>1200 (8.6%)</td>
</tr>
<tr>
<td>Iodoquinol (3435)</td>
<td>7350 (5.7%)</td>
<td>80 (0.6%)</td>
</tr>
<tr>
<td>Leflunomide (27169)</td>
<td>1460 (1.1%)</td>
<td>480 (3.5%)</td>
</tr>
<tr>
<td>Methotrexate (6851)</td>
<td>17710 (13.7%)</td>
<td>1750 (12.6%)</td>
</tr>
<tr>
<td>Oxyquinoline (110)</td>
<td>220 (0.2%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Sulfasalazine (9524)</td>
<td>5320 (4.1%)</td>
<td>570 (4.1%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>129560</td>
<td>13890</td>
</tr>
</tbody>
</table>
**Case #3 – “Big Data”**

## Results

% of patients with comorbidities induced by AZA. Diagonal represents the proportion of patients experiencing a single side effect. Relative risk of developing a comorbidity (relative to any one of 12 anti-rheumatic drugs) is indicated by the cell color.

<table>
<thead>
<tr>
<th>Primary Effect</th>
<th>Cr</th>
<th>AST, ALT</th>
<th>Bili</th>
<th>Neutropenia</th>
<th>Neutrophilia</th>
<th>Temp</th>
<th>BP</th>
<th>Hgb</th>
<th>LDH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cr</td>
<td>7.9%</td>
<td>30.8%</td>
<td>7.7%</td>
<td>15.4%</td>
<td>38.5%</td>
<td>53.8%</td>
<td>53.8%</td>
<td>69.2%</td>
<td>30.8%</td>
</tr>
<tr>
<td>AST, ALT</td>
<td>19.0%</td>
<td>14.1%</td>
<td>33.3%</td>
<td>9.5%</td>
<td>23.8%</td>
<td>33.3%</td>
<td>14.3%</td>
<td>47.6%</td>
<td>19.0%</td>
</tr>
<tr>
<td>Bili</td>
<td>4.5%</td>
<td>31.8%</td>
<td>14.1%</td>
<td>9.1%</td>
<td>45.5%</td>
<td>27.3%</td>
<td>36.4%</td>
<td>45.5%</td>
<td>13.6%</td>
</tr>
<tr>
<td>Neutropenia</td>
<td>2.4%</td>
<td>2.4%</td>
<td>2.4%</td>
<td>24.3%</td>
<td>0.0%</td>
<td>4.7%</td>
<td>8.2%</td>
<td>7.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Neutrophilia</td>
<td>3.6%</td>
<td>3.6%</td>
<td>7.3%</td>
<td>0.0%</td>
<td>45.2%</td>
<td>7.3%</td>
<td>13.9%</td>
<td>18.2%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Temp</td>
<td>15.6%</td>
<td>15.6%</td>
<td>13.3%</td>
<td>8.9%</td>
<td>22.2%</td>
<td>13.1%</td>
<td>60.0%</td>
<td>55.6%</td>
<td>4.4%</td>
</tr>
<tr>
<td>BP</td>
<td>4.6%</td>
<td>2.0%</td>
<td>5.3%</td>
<td>4.6%</td>
<td>12.5%</td>
<td>17.8%</td>
<td>29.5%</td>
<td>20.4%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Hgb</td>
<td>16.1%</td>
<td>17.9%</td>
<td>17.9%</td>
<td>10.7%</td>
<td>44.6%</td>
<td>44.6%</td>
<td>55.4%</td>
<td>28.4%</td>
<td>19.6%</td>
</tr>
<tr>
<td>LDH</td>
<td>30.8%</td>
<td>30.8%</td>
<td>23.1%</td>
<td>0.0%</td>
<td>76.9%</td>
<td>15.4%</td>
<td>23.1%</td>
<td>84.6%</td>
<td>59.1%</td>
</tr>
</tbody>
</table>

Relative Risk: 1.00 1.25 1.50 1.75 2.00 2.25 2.50 3.00 3.50 4.00 4.50 5.00
Case #3 – “Big Data”

Results

VA Clinical Informatics: Four programs highlighting advances and innovation in analytics

Sarah Russell, MD
sarah.russell@va.gov
CMIO, VA Palo Alto Healthcare System
- Clinical data driving bio-surveillance
- Corporate data warehouse and dashboards
- Patient engagement analytics
- Machine learning and free text analysis of the medical record
HAISS Data Architecture
(Data Input)

VistA Data
Accessed from 128 data sources across VHA

HAISS Data Warehouse
Surveillance system approach

Step one: pull from heterogeneous data sources

Step two: do temporal analysis – with focus on anomalies

Step three: expert evaluates pattern and determines relevance given objectives
VA telephone encounter data for influenza ICD-9-CM coded calls and emergency department/urgent care visits
Corporate data warehouse

= Governance Board

Enterprise
Corporate data warehouse: unique applications in pharmacy
# Medication Safety

<table>
<thead>
<tr>
<th>Dashboard Instructions</th>
<th>Actual</th>
<th>Target</th>
<th>Not Met</th>
<th>Patients</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amiodarone</strong></td>
<td>60.3%</td>
<td>62%</td>
<td>▲</td>
<td>1,156</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Amiodarone - LFT &lt; 6 Months</td>
<td>64.9%</td>
<td>68%</td>
<td>▲</td>
<td>406</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Amiodarone - TSH &lt; 6 Months</td>
<td>55.6%</td>
<td>55%</td>
<td>▶️</td>
<td>513</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td><strong>Azathioprine</strong></td>
<td>69.2%</td>
<td>72%</td>
<td>▲</td>
<td>164</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Azathioprine - CBC &lt; 3 Months</td>
<td>60.4%</td>
<td>70%</td>
<td>◤️</td>
<td>65</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Azathioprine - LFT &lt; 6 Months</td>
<td>78.0%</td>
<td>76%</td>
<td>▶️</td>
<td>36</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td><strong>Carbamazepine</strong></td>
<td>68.1%</td>
<td>72%</td>
<td>▲</td>
<td>689</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Carbamazepine - CBC &lt; 12 Months</td>
<td>81.3%</td>
<td>85%</td>
<td>▲</td>
<td>129</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Carbamazepine - Level &lt; 6 Months</td>
<td>26.0%</td>
<td>29%</td>
<td>◤️</td>
<td>510</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Carbamazepine - LFT &lt; 12 Months</td>
<td>81.6%</td>
<td>86%</td>
<td>▲</td>
<td>127</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Carbamazepine - Sodium &lt; 12 Months</td>
<td>83.5%</td>
<td>88%</td>
<td>▲</td>
<td>114</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td><strong>Glyburide (65 y/o or older)</strong></td>
<td>90.2%</td>
<td>91%</td>
<td>▲</td>
<td>2,681</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Glyburide - Scr &lt; 2 if at least 65 y/o</td>
<td>90.2%</td>
<td>91%</td>
<td>▲</td>
<td>263</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td><strong>Leflunomide</strong></td>
<td>64.8%</td>
<td>78%</td>
<td>◤️</td>
<td>135</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Leflunomide - CBC &lt; 3 Months</td>
<td>65.9%</td>
<td>79%</td>
<td>◤️</td>
<td>46</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Leflunomide - LFT &lt; 3 Months</td>
<td>63.7%</td>
<td>77%</td>
<td>◤️</td>
<td>49</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td><strong>Lithium</strong></td>
<td>74.3%</td>
<td>76%</td>
<td>▲</td>
<td>896</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Lithium - CBC &lt; 12 Months</td>
<td>83.3%</td>
<td>85%</td>
<td>▲</td>
<td>150</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Lithium - Level &lt; 12 Months (at least 900mg/d)</td>
<td>81.7%</td>
<td>87%</td>
<td>▲</td>
<td>99</td>
<td><a href="#">Definition</a></td>
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<tr>
<td>Lithium - Scr &lt; 12 Months</td>
<td>89.5%</td>
<td>91%</td>
<td>▲</td>
<td>94</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td>Lithium - TSH &lt; 6 Months</td>
<td>50.2%</td>
<td>55%</td>
<td>▲</td>
<td>446</td>
<td><a href="#">Definition</a></td>
</tr>
<tr>
<td><strong>Mercaptopurine</strong></td>
<td>75.0%</td>
<td>84%</td>
<td>▼️</td>
<td>392</td>
<td><a href="#">Definition</a></td>
</tr>
</tbody>
</table>
Dashboard: primary care

<table>
<thead>
<tr>
<th>Patient Populations</th>
<th>Patients</th>
<th>Definition</th>
<th>Patients</th>
<th>Definition</th>
<th>Patients</th>
<th>Definition</th>
<th>Patients</th>
<th>Definition</th>
<th>Indicator Key</th>
<th>Target</th>
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<tbody>
<tr>
<td>Diabetes</td>
<td>4,829</td>
<td>Definitions</td>
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<td></td>
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<td></td>
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<td></td>
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<tr>
<td>Ischemic Heart Disease</td>
<td>2,514</td>
<td>Definitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>8,552</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

### FY11 Performance Measures - DM and IHD

<table>
<thead>
<tr>
<th>Measure</th>
<th>Actual</th>
<th>Target</th>
<th>Not Met</th>
<th>No Measure</th>
<th>Trends</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes Mellitus (Composite)</td>
<td>88%</td>
<td>88%</td>
<td>154</td>
<td></td>
<td>Trends</td>
<td>Definitions</td>
</tr>
<tr>
<td>Diabetes-Outp-HBA1C Measured Annually</td>
<td>96.8%</td>
<td>96%</td>
<td>154</td>
<td></td>
<td>Trends</td>
<td>Definitions</td>
</tr>
<tr>
<td>Diabetes Outp and HBA1C &gt; 9 (lower is better)</td>
<td>19.5%</td>
<td>19%</td>
<td>790</td>
<td>154</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes Outp LDL Measured Annually</td>
<td>95.9%</td>
<td>96%</td>
<td>198</td>
<td></td>
<td>Trends</td>
<td>Definitions</td>
</tr>
<tr>
<td>Diabetes Outp and LDL&lt;100</td>
<td>73.1%</td>
<td>75%</td>
<td>1,101</td>
<td>198</td>
<td>Trends</td>
<td>Definitions</td>
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<tr>
<td>Diabetes and BP &lt; 140/90</td>
<td>79.5%</td>
<td>78%</td>
<td>694</td>
<td>96</td>
<td>Trends</td>
<td>Definitions</td>
</tr>
<tr>
<td>Diabetes Outp and Timely Retinal Exam</td>
<td>99.8%</td>
<td>99%</td>
<td>11</td>
<td></td>
<td>Trends</td>
<td>Definitions</td>
</tr>
<tr>
<td>Diabetes Outp and Renal Function Testing</td>
<td>90.2%</td>
<td>92%</td>
<td>473</td>
<td></td>
<td>Trends</td>
<td>Definitions</td>
</tr>
<tr>
<td>Ischemic Heart Disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IHD - Outp LDL Measured Annually</td>
<td>94.9%</td>
<td>92%</td>
<td>128</td>
<td></td>
<td>Trends</td>
<td>Definitions</td>
</tr>
<tr>
<td>IHD - Patients with LDL &lt; 100</td>
<td>74.2%</td>
<td>69%</td>
<td>521</td>
<td>128</td>
<td>Trends</td>
<td>Definitions</td>
</tr>
<tr>
<td>Hypertension and BP &lt; 140/90</td>
<td>77.3%</td>
<td>72%</td>
<td>1,789</td>
<td>152</td>
<td>Trends</td>
<td>Definitions</td>
</tr>
</tbody>
</table>
## Patient engagement analytics

- **Unbearable Pain**
  - Topic: Unbearable Pain
  - Last reply: about 6 hours ago by Hector
  - Tags: Migraines, painful, Seizures, Trigeminal Neuralgia
  - Sherry created on Mar 21, 2014
  - Last reply by Hector
  - Hector: Sorry to hear your are feeling so bad. I just got back from the national epilepsy march working as a volunteer and had a good time. I saw so many people who are fighting epilepsy in different ways kids...

- **Stigma**
  - Topic: Stigma
  - Last reply: about 16 hours ago by Tyler
  - Tags: Life with Epilepsy, stigma
  - Seize created on Mar 07, 2014
  - Last reply by Tyler
  - Tyler: I once had some paramedics come to my home here in Denver and they stood over me yelling at me to stop faking it and they were harassing my dad about what illegal drugs I take and when was the...

- **hitting those we have an emotional tie with very depressing for me!**
  - Topic: hitting those we have an emotional tie with very depressing for me!
  - Last reply: 3 days ago by Sherry
  - Tags:-depressive disorder
  - Tyler created on Mar 19, 2014
  - Last reply by Sherry
  - Sherry: Aw Turrell-forgive yourself! Your dad knows you didn’t mean it. We can’t always have control of ourselves. Sux, I know...the nature of the beast n’ all that...

- **Do your meds tamp down your auras/warnings?**
  - Topic: Do your meds tamp down your auras/warnings?
  - Last reply: 6 days ago by Epidean
  - Tags: Auras
  - Sherry created on Mar 17, 2014
  - Last reply by Epidean
  - Epidean: well... we all know they believe there is a link between the migraines and the seizures... they just can’t tell us much about it... i feel the only way to be sure is to have the egg on when having...
Palo Alto VA and Kyron: Novel text-mining approach to cohort patients and run retrospective analyses
Patients

gerd - gastro-esophageal reflux disease

Cohort Results

6,325 patients (partial results) | 14.15s

Define Cohort

Interventions

proton pump inhibitors
h2-receptor antagonists

Outcomes

myocardial infarction acute
cardiac arrest
cerebrovascular disease
defibrillation

Show Evidence

Conditions

Symptoms
Personal history of ...
Respiration Disorder...
General symptom
MENTAL, BEHAVIORAL
Abdominal Pain
Lipid Metabolism Dis...
CHRONIC OBSTRUCT
Chest Pain
Asthma
Screening examination...
Symptom of head and 
Nausea and vomiting
Coughing
Mental disorders
Congenital Abnormali...
Functional digestive...
Dyspnea
Dysfunction Disorder...
Hyperlipidemia, gout...
Hernia of abdominal ...

Procedures

Operative Surgical P...

Drugs

General anesthetic d...
Fentanyl 0.06 mg/ml ...
Antischizophrenics, cla...
Lidocaine
Ondansetron 2 mg/ml
Midazolam 1 mg/ml in...
Proton pump inhibito...
Antiglaucoma prepara...
Anti-anxiety agents
Propofol
Benzodiazepine deriv...
Morphine sulfate 2 m...
Pantoprazole
Hydrocodone
Lactate
Magnesium hydroxide
Albuterol
Epinephrine
Enemas for constipat...
Lipid modifying agent...
Simethicone
Text Analytics at Stanford Children’s Health

Jonathan Palma, MD, MS
AMDIS Physician-Computer Connection Symposium
19 June 2014
Proofs of Concept

• IBM Content Analytics
  – Watson-like NLP technology
  – Search/analytics application
  – Use case-specific content

• HP Autonomy Healthcare Analytics
  – IDOL statistical inference algorithms
  – Combined with medical terminologies
  – Web-based search application
HP Autonomy Pilot

- Business Owners: Quality and Clinical Effectiveness Team

- Use Case: US News and World Report Survey
HP Autonomy Pilot

• Clinical data from 2011 – 2013
  – ~115k patients, ~390k encounters, ~3 million documents

• Structured
  – Patient ID, age
  – Encounter ID, location
  – Diagnosis (ICD) and Procedure (CPT) codes
  – Document metadata (e.g. author, attending provider)

• Unstructured
  – Clinical documents
  – Radiology reports
HP Autonomy Healthcare Analytics: Core Functions

- Cohort Identification
- Chart Abstraction
- Advanced Analytics
Concept search (SNOMED) for ECMO patients
ECMO patients with disposition “Expired”
Comparison of Expired vs. non-Expired ECMO patients
Comparison of Expired vs. non-Expired ECMO patients
Additional Filter for Congenital Diaphragmatic Hernia patients
Topic Map of Expired ECMO patients
HP Autonomy Healthcare Analytics: Current Use

• Venous Thromboembolism (Cohort Identification, Chart Abstraction)
• Surgical Site Infections (Cohort Comparison)
• Investigation of other Hospital Acquired Conditions
• Identification of process and outcomes measures
• Development of standardized care protocols
HP Autonomy Healthcare Analytics: Future Directions

- Availability to service chiefs, medical staff
  - Self service analytics tool
  - Security/Privacy considerations
- Facilitate traditional research
- Support the concept of a Learning Healthcare System
  - Insight into past experience (i.e. practice-based evidence)
  - Allow for increasingly data driven care decisions
An Application of “Big Data Analytics” at Stanford Children’s: Bedside Monitor Alarm Fatigue

Veena Goel, M.D.
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Medical device alarm safety

Scope of problem

100s $\rightarrow$ 1,000s $\rightarrow$ 10,000s

100s of alarm signals per patient, per day = 1,000s of alarm signals on each unit = tens of thousands of alarm signals throughout a hospital per day

85-99\% of alarm signals don’t require clinical intervention
Alarm Fatigue

Clinicians become desensitized, overwhelmed or immune to the sound of an alarm.

Fatigued clinicians may:
• Turn down alarm volume
• Turn off alarm
• Adjust alarm settings

These actions can have serious or fatal consequences.
Joint Commission Sentinel Event database

From January 2009-June 2012,

98 alarm related events reported* → 80 resulted in death

13 resulted in permanent loss of function

5 resulted in unexpected additional care or extended stay

* The reporting of most sentinel events to The Joint Commission is voluntary and represents only a small portion of actual events. Therefore, these data are not an epidemiologic data set and no conclusion should be drawn about the actual relative frequency of events or trends in events over time.
Impetus for change

- 2014 National Patient Safety Goal:
  - Phase 1 (2/2014): alarms to be established as an organization priority by all hospitals.
  - Phase 2 (2/2016): all hospitals expected to develop and implement specific policies and procedures and to educate organization members about alarm system management.
Recommendations/Solutions

1. Have a process for safe alarm management and response
2. Inventory alarm-equipped medical devices
3. Have guidelines for alarm settings
4. Have guidelines for tailoring alarm settings and limits for individual patients
5. Inspect, check, and maintain alarm-equipped devices

These actions correspond with recommendations from The Joint Commission, the Association for the Advancement of Medical Instrumentation (AAMI) and ECRI Institute.

For additional solutions view our Sentinel Event Alert at
www.jointcommission.org/sea_issue_50/

The Joint Commission
1. Monitor less patients

- Epic EMR roll-out in May 2014
  - Changed patient admission order sets.
  - Unchecked default order to place patients on monitors.
- Working to determine ‘best practices’ around monitor use.
- Collaboration with and education of nursing management and staff.
1. Monitor less patients

- Epic EMR roll-out in May 2014
  - Changed patient admission order sets.
  - Unchecked default order to place patients on monitors.
- Working to determine ‘best practices’ around monitor use.
- Collaboration with and education of nursing management and staff.
2. Data driven vital sign parameters

- Analysis of vital signs of hospitalized patients (stratified by age) in the calendar year 2013 at our institution to create percentile tables for heart rate (HR) and respiratory rate (RR).

- Modeled after work done by Bonafide et al. (Pediatrics, 2013)
  - Created percentile curves for HR and RR of hospitalized children.
  - Found that 12-54% of HR observations and 32-40% of RR deviated from currently accepted ranges.
Number of out-of-range HR & RR values in 2013 at LPCH

Combined HR and RR alarms using different limits

Vital Sign Parameters

Number of Alarms

- > Upper limit
- < Lower limit

Current Using LPCH Calculated
1st/99th %iles
Using LPCH Calculated
5th/95th %iles
Current vs. Proposed HR parameters by age
Current vs. Proposed RR parameters by age

<table>
<thead>
<tr>
<th>Age</th>
<th>Current RR Parameters</th>
<th>Proposed RR Parameters</th>
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<tbody>
<tr>
<td>1-6 months</td>
<td>24</td>
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<td>6 months-2 years</td>
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<td>&gt;12 years</td>
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Safety analysis of proposed new vital sign parameters

- Currently analyzing all rapid-response team calls and patient code events from 2013.

- Goal = to increase specificity of alarms while maintaining sensitivity.
3. Epidemiology of monitor alarms

- Unique data repository containing minute-by-minute monitor alarm and waveform data for all hospitalized patients since 2008.
  - RDE ‘research data export’ program links from the Philips monitors.
- Performing epidemiology analysis of alarms using this database.
Thank you!

Questions/Comments? Please contact me at: vvgoel@stanford.edu
CEP Use Case

Sameer Badlani, MD, FACP
CMIO
University of Chicago Medicine
Disclosures

• The eCART algorithm is the intellectual property of the University of Chicago.

• The slides for the Cardiac Arrest algorithm are courtesy Dana Edelson, MD
January-April Ward Case Reviews

- No system failure identified: 13%
- Should have been DNAR: 25%
- ICU/ED triage failure: 42%
- Failure to call RRT: 54%

[n=24 cardiac arrests]
January-April Ward Case Reviews

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[n=24 cardiac arrests]
Near Miss Analysis

Prolonged hypotension without RRT activation:

<table>
<thead>
<tr>
<th>Time</th>
<th>Temp</th>
<th>Temp Source</th>
<th>Heart Rate/Pulse</th>
<th>Pulse Method</th>
<th>Resp</th>
<th>BP</th>
<th>MAP</th>
<th>MAP Method</th>
<th>BP Method</th>
<th>Position for BP</th>
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Using Electronic Health Record Data to Develop and Validate a Prediction Model for Adverse Outcomes in the Wards

Matthew M. Churpek, MD, MPH1,2; Trevor C. Yuen1; Seo Young Park, PhD3; Robert Gibbons, PhD3; Dana P. Edelson, MD, MS1

Objective: Over 200,000 in-hospital cardiac arrests occur in the United States each year and many of these events may be preventable. Current vital sign–based risk scores for ward patients have demonstrated limited accuracy, which leads to missed opportunities to identify those patients most likely to suffer cardiac arrest and inefficient resource utilization. We derived and validated a prediction model for cardiac arrest while treating ICU transfer as a competing risk using electronic health record data.

Design: A retrospective cohort study.

Setting: An academic medical center in the United States with approximately 500 inpatient beds.

Patients: Adult patients hospitalized from November 2008 until August 2011 who had documented ward vital signs.

Interventions: None.

Measurements and Main Results: Vital sign, demographic, location, and laboratory data were extracted from the electronic health record and investigated as potential predictor variables. A person-time multinomial logistic regression model was used to simultaneously predict cardiac arrest and ICU transfer. The prediction model was compared to the VitalPAC Early Warning Score using the area under the receiver operating characteristic curve and was validated using three-fold cross-validation. A total of 56,649 controls, 109 cardiac arrest patients, and 2,543 ICU transfers were included. The derived model more accurately detected cardiac arrest (area under the receiver operating characteristic curve, 0.88 vs 0.78; p < 0.001) and ICU transfer (area under the receiver operating characteristic curve, 0.77 vs 0.73; p < 0.001) than the VitalPAC Early Warning Score, and accuracy was similar with cross-validation. At a specificity of 93%, our model had a higher sensitivity than the VitalPAC Early Warning Score for cardiac arrest patients (65% vs 41%).

Conclusions: We developed and validated a prediction tool for ward patients that can simultaneously predict the risk of cardiac arrest.
eCART Proof of Concept (Feb 2013 – Apr 2014)

- None: 8%
- Proactive rounding: 25%
- Automatic RRT: 67%

Median 30 hrs prior to arrest
Median 42 hrs prior to arrest

n=12 arrests
Accurate detection of cardiac arrest may improve outcomes

Detection
Cardiac arrest
Death
Baseline
RRT
ICU

Courtesy: Dana Edelson, MD
Use Case

• Problem
  – High rate of inpatient cardiac arrests
  – Unpredictable yet if detected early based on physiological and other signals can lead to improved outcomes

• Data Available but no actionable intelligence
  – Continuous physiological and laboratory monitoring
  – EHR provides easy access but has unmanageable amount of data/information

• Solution
  – Real time statistical model to detect a possible cardiac event
  – Use CEP engine to process information and alert on call physician
  – Suggest actions
Complex Event Processing

- **Event processing** is a method of tracking and analyzing (processing) streams of information (data) about things that happen (events),[1] and deriving a conclusion from them.

- **Complex event processing**, or CEP, is event processing that combines data from multiple sources[2] to infer events or patterns that suggest more complicated circumstances. The goal of complex event processing is to identify meaningful events (such as opportunities or threats)[3] and respond to them as quickly as possible.

Service Oriented Architecture and Complex Event Processor

HL7 Events

Real time / low latency

Data oriented

EDA

Complex Event Processing

Rule Authoring

Messaging

TIBCO EMS

TIBCO ActiveSpaces

BPM & SOA

TIBCO BusinessWorks

TIBCO BusinessEvents

Predictive Analytics

Visual Analytics

Real-time Dashboards

TIBCO BE Decision Manager

TIBCO BE Views

TIBCO RTView

EHR

TIBCO Spotfire

TIBCO Spotfire R and S+

TIBCO Spotfire

THE UNIVERSITY OF CHICAGO MEDICINE
Questions

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**My Patient**

A 55 year old female of Vietnamese heritage with known asthma presents to her physician with new onset moderate hypertension

**Intervention**

antihypertensives

**Outcome**

Diastolic pressure < 90 mm Hg

Analytics Panel

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