New York Metro Chapter

Business Intelligence & Predictive Analytics in the Healthcare Environment

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President: Healthcare Intelligence, LLC
Agenda:

- Healthcare Industry Context:
  - Fundamental Transformation & Social Commitment
- Identify the Scope & Sources of Data Resources
  - Regulatory Environment (HIPAA & HITECH)
- Recognize Problems Associated with:
  - Data Management, & IT Systems infrastructure
    - Including: clean up, exploring & analyzing ‘Big Data’
  - Data Mining Goals & Objectives (beyond Spreadsheets)
  - Descriptive, Predictive and Prescriptive Analytics
- Business Intelligence vs Clinical Decision Support
  - Promote Critical Thinking, Analytical & Research Skills
  - Promote Quantitative Management Skills (Identify Questions)
Health care not only is the key to our fiscal future, but also contains a massive opportunity to improve efficiency, with credible estimates suggesting that as much as $700 billion per year, or 5 percent of GDP, of healthcare services delivered in the United States don’t improve health outcomes.

*Beyond Economics 101: Insights into Healthcare Reform from the Congressional Budget Office, Peter R. Orszag, October 2008
The US Health Care Delivery System

• Scope, Size & Description
  – $2.9 Trillion, $9,255/person, 17.4% GDP
  – Twice the median per capita of 30 Industrialized Nations

• Fragmented Components & Providers
  – Hospitals & Institutions (Nursing Homes, Specialty Hosp)
  – Physicians & Clinical Services
  – Other Professional Services & Personal Health Care
  – Prescription Drugs, Durable Medical Equipment
  – Public Health, Research, etc.

• National Health Expenditures at 19.6% in Ten Yrs.
  – Technology, Chronic Diseases, Aging Population, Administrative Costs
  – Integrated & Accountable Care Organization Initiatives
U.S. Health Care Spending vs. Other Countries

Note: PPP = purchasing power parity—an estimate of the exchange rate required to equalize the purchasing power of different currencies, given the prices of goods and services in the countries concerned.

Source: OECD Health Data 2010 (Oct. 2010).
"We have to bring the science of management back into Healthcare"

Donald Berwick, MD
Institute of Healthcare Improvement
The Future of Personalized Community-based Health Care

- Hospice
- Home Care
- House Calls
- NORC
- Long Term Care
- Sub-Acute
- Disease Management
- Connected Communities
- Social Networks
- E-Portal Health “E” Care
- Education
- Healthy Nutrition
- Physical Activity
- Rest/Recovery
- Rehabilitation
- Acute Hospitals
- Diagnostic
- Specialty Programs
- Behavioral
- CEMS
- Pharmacy
- Risk Assessment
- Screening
- Immunization
- Predictive Modeling
- Executive Health
- Genetic Knowledge
- Prevention/Early Detection
- Community Services

THE HEALTH CARE TEAM
The “Big Data” Challenge

• Transaction Based Systems (Billing) & EMR’s
• Population and Clinically Based Analytics
  – Community Health Status
  – Longitudinal – Episodes of Care
• Data Scientist Perspective
  – Data Governance, Business Understanding
  – Systems, Data & Analytics capabilities
Health Care Data Evolution

• Medical and Billing Records
  – Traditional Paper Medical & Billing Records
  – Electronic Billing Records (Insurance & State Repository)

• Professional Credentials
  – State Department of Education

• Economic & Competitive Metrics
  – Institutional Cost Reports (CMS)
  – American Hospital Assoc. Survey

• Commercial Data Sources (i.e., Truven HC)
  – Insurance Intermediary Transactions
‘Big Data’ Healthcare Environment

- One State of:
  - 24 Million Lives
  - 15 years transactional activity across venues
  - 180 million records:
    - 5,000 characters/450 fields: 20 Terabyte

- Future:
  - Multiple States
  - All-Claims to include Physician offices, Pharma & Diagnostics
  - All-Claims DB: 1.2 Billion records per year
Demonstration Overview

- **Exploratory Data Analysis (EDA) Descriptive**
  - Inpatient Activity: Service & Use Trends
  - Emergency Room Activity: Dependence
  - Care Continuum: Home Care, LTC/SNF Amb. Surgery
  - Payor/Population Mix: Shift to Medicare

- **Predictive Analytics:**
  - State-Space Forecasting Models (Univariate Family of Exponential Smoothing & ARIMA)
  - Multi-Variate/Simulation Models (Longer term environmental & systems change)

- **Prescriptive/Machine Learning Analytics**
  - A Branch of AI; Decision tree, Neural Networks, Inductive Logic, Association Rules, Clustering, Bayesian Network. Pattern Recognition.
  - Natural Language Processing
Long Term Trends – All New York State Hospitals

Westchester County-Total Inpatient Discharges

In-Patients per Month

Jan-97 to Jan-12

6% Decline
Physical Resources In Use

Westchest County-Occupied Beds

- 15% Overall Decline in Utilization
- 6% Decline in Discharges
- 13% Decline in Length of Stay
- Higher Intensity of Services
Westchester Population Out-Migration

- Region 5
- Region 6
- Region 8 & 9

- NORMET
- DISCHARGES
- PATIENT DAYS

- Bronx
- Manhattan
Dependence on Emergency Services

Westchester County - Emergency Room Admissions

Emergency Room Admission Ratio

ER to Total Admissions
Inpatient Discharge Referrals

Inpatient Discharges per Month

Skilled Nursing Facility

Home Care

Home Care  Skilled Nursing Facility

Jan-97  Jan-98  Jan-99  Jan-00  Jan-01  Jan-02  Jan-03  Jan-04  Jan-05  Jan-06  Jan-07  Jan-08  Jan-09  Jan-10  Jan-11  Jan-12
Population: 961,670
Density: 1879/Sq.Mi
Births that occurred prior to 37 weeks of gestation, as percent of live births, 2010-2012
Predictive Modeling Application
Geographic Mapping
Primary Markets by Hospital
Hospital Admissions & LOS
Hospital Forecast Patient Activity

- 22,000 Pts/Yr
- 20,000 Pts/Yr

Patients/Mo.

Jan-06  |  Jan-07  |  Jan-08
Multi-Level, Three-Dimensional Framework For Forecast Decision Support

- Period
- Place
- Product

Demand Forecasting

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Summary Level Considerations

• Homogeneity
  – Do lower levels have common seasonality pattern?

• Intermittency
  – Do lower levels show periods of zero demand?

• Volatility
  – Do lower levels show different events and irregularities?

Dilemma: It is necessary to collect data at lowest practical level, but it is essential to create forecasting models at highest possible levels.
Step 1: Data Preparation

All Data Are Wrong, Some Are Useful

Product View

Customer View

Sourcing View

*They need the SHIP forecast for *Type 1* upgrades to *Type 2* for EMEA Manufacturing Industry Customers - sold through Business Partners?*
Intelligent Dashboard
History, Adjustments & Forecasts

Customer Segmentation

Product Hierarchy

History (light Blue)
Forecast (Dark Blue)

Display
- Year By Period
- YTD
- % Total

Type
- History Only
- + Statistical Forecasts
- + Managed Forecasts

Conversion
- PatientCnt
- Cost
- PatientDay

Update
- Product
- Customer
- LOS

Model

Review

Overrides

Performance

<table>
<thead>
<tr>
<th></th>
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<td>474</td>
<td>459</td>
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<td>502</td>
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<td>5125</td>
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Fcast: 12/30/2004  PatientCnt
Display demand/forecast units/$ over time.  Fcast # 14
Environmental Change

- Berger Commission Modeling of Closures
  - Demonstration

- Predictive Modeling: Rules & Ratios

- Monte Carlos Modeling: Multiple Distribution Models & Random Cycles
Berger Commission Model

Main Menu

- Background
- Decisions
- Dashboard

Decisions: Hospital Closures

- Closure of Winthrop
- Closure of Nassau U
- Closure of Mercy
- Closure of North Shore
- Closure of Franklin
- Closure of St Johns
- Closure of North Island
- Closure of St Francis
- Closure of Long Beach
- Closure of Peninsula
- Closure of Others

- Assume no additional outmigration for service line closures
Intermediate Decisions

1. Initial Normal Competition in Market Place
2. Mercy & Franklin: Close Trauma, Pediatrics & Maternity Services
3. Long Beach Hospital Closure
4. Mercy Hospital Closure
End of year: 2009

**Dashboard**

**Total Admissions (000)**

- Year: 2005 to 2010
- Value: 24,347

**ADC**

- Year: 2005 to 2010
- Value: 457

**PSA market share %**

- Year: 2005 to 2010
- Value: 38.0%

**Operating margin %**

- Year: 2005 to 2010
- Value: 8.1%

**Buttons:**
- Decisions
- Main Menu
- Back
- RUN
- Reset
- Save
- Reopen
Market share

North market share %

South market share %

East market share %

West market share %

4.3%

42.3%

4.5%

8.3%
## Utilization detail

<table>
<thead>
<tr>
<th>Time (Year)</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
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<tbody>
<tr>
<td>Total patient days</td>
<td>117,977</td>
<td>119,656</td>
<td>124,937</td>
<td>143,446</td>
<td>167,112</td>
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<td>ADC</td>
<td>323</td>
<td>327</td>
<td>342</td>
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<td>ALDS</td>
<td>6.7</td>
<td>6.7</td>
<td>6.5</td>
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### Patient days by Department

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<th>Dept.</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
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<tbody>
<tr>
<td>Medicine patient days</td>
<td>56,814</td>
<td>57,681</td>
<td>58,893</td>
<td>67,563</td>
<td>79,615</td>
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<tr>
<td>Surgery patient days</td>
<td>42,095</td>
<td>42,721</td>
<td>43,783</td>
<td>50,097</td>
<td>58,572</td>
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<td>Pediatrics patient days</td>
<td>2,267</td>
<td>2,301</td>
<td>2,413</td>
<td>2,785</td>
<td>3,238</td>
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<tr>
<td>Maternal patient days</td>
<td>4,391</td>
<td>4,432</td>
<td>5,947</td>
<td>5,642</td>
<td>5,699</td>
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<tr>
<td>Newborn patient days</td>
<td>3,697</td>
<td>3,734</td>
<td>5,096</td>
<td>4,787</td>
<td>4,783</td>
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<tr>
<td>Psychiatry patient days</td>
<td>9,341</td>
<td>9,426</td>
<td>9,462</td>
<td>13,356</td>
<td>16,158</td>
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### Patient days by Service Line

<table>
<thead>
<tr>
<th>Service Line</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
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<tbody>
<tr>
<td>Oncology patient days</td>
<td>7,461</td>
<td>7,606</td>
<td>7,654</td>
<td>9,515</td>
<td>10,005</td>
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<tr>
<td>Trauma patient days</td>
<td>5,429</td>
<td>5,525</td>
<td>6,405</td>
<td>7,521</td>
<td>7,552</td>
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<td>GVU patient days</td>
<td>669</td>
<td>669</td>
<td>688</td>
<td>697</td>
<td>853</td>
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<td>Cardiac patient days</td>
<td>12,758</td>
<td>13,040</td>
<td>13,063</td>
<td>14,401</td>
<td>16,185</td>
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<td>Maternal patient days</td>
<td>7,893</td>
<td>7,968</td>
<td>10,874</td>
<td>10,211</td>
<td>10,199</td>
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<td>Plastic patient days</td>
<td>2,166</td>
<td>2,125</td>
<td>2,247</td>
<td>2,766</td>
<td>3,335</td>
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<td>GI patient days</td>
<td>13,787</td>
<td>14,025</td>
<td>14,203</td>
<td>16,278</td>
<td>19,226</td>
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<td>Hematology patient days</td>
<td>1,243</td>
<td>1,299</td>
<td>1,294</td>
<td>1,402</td>
<td>1,606</td>
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</table>
## Income Statement

<table>
<thead>
<tr>
<th>Time (Year)</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
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</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td></td>
<td></td>
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<tr>
<td>Total inpatient revenue</td>
<td>$208.71</td>
<td>$220.65</td>
<td>$242.60</td>
<td>$287.05</td>
<td>$344.64</td>
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<tr>
<td>Total ambulatory revenue</td>
<td>$69.86</td>
<td>$73.95</td>
<td>$78.58</td>
<td>$83.56</td>
<td>$89.18</td>
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<tr>
<td>Net patient services revenue</td>
<td>$278.57</td>
<td>$294.60</td>
<td>$321.18</td>
<td>$370.60</td>
<td>$433.82</td>
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<tr>
<td>Other revenue from operations</td>
<td>$13.08</td>
<td>$13.83</td>
<td>$15.08</td>
<td>$17.40</td>
<td>$20.37</td>
</tr>
<tr>
<td>Investment earnings</td>
<td>$28.08</td>
<td>$28.21</td>
<td>$28.34</td>
<td>$29.18</td>
<td>$31.02</td>
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<tr>
<td>Total operating revenue</td>
<td>$319.73</td>
<td>$336.64</td>
<td>$364.60</td>
<td>$417.18</td>
<td>$485.21</td>
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<tr>
<td><strong>Expenses</strong></td>
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<td></td>
</tr>
<tr>
<td>Salaries and wages</td>
<td>$118.22</td>
<td>$123.87</td>
<td>$132.46</td>
<td>$153.48</td>
<td>$180.56</td>
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<td>Employee benefits</td>
<td>$34.45</td>
<td>$35.37</td>
<td>$36.96</td>
<td>$40.35</td>
<td>$46.70</td>
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<tr>
<td>Temporary labor</td>
<td>$3.55</td>
<td>$3.72</td>
<td>$3.97</td>
<td>$4.60</td>
<td>$5.42</td>
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<tr>
<td>Medical and surgical supplies</td>
<td>$69.41</td>
<td>$73.58</td>
<td>$77.80</td>
<td>$85.03</td>
<td>$95.19</td>
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<td>Malpractice expense</td>
<td>$7.00</td>
<td>$7.95</td>
<td>$9.60</td>
<td>$11.96</td>
<td>$15.32</td>
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<tr>
<td>Other supplies and expenses</td>
<td>$33.68</td>
<td>$33.87</td>
<td>$36.36</td>
<td>$41.02</td>
<td>$47.04</td>
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<td>Leases and rentals</td>
<td>$3.13</td>
<td>$3.29</td>
<td>$3.45</td>
<td>$3.63</td>
<td>$3.81</td>
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<td>Bad debt expense</td>
<td>$17.05</td>
<td>$18.02</td>
<td>$19.64</td>
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<tr>
<td>Total operating expenses</td>
<td>$286.48</td>
<td>$299.67</td>
<td>$320.24</td>
<td>$362.75</td>
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<td><strong>EBITDA</strong></td>
<td>$33.24</td>
<td>$36.97</td>
<td>$44.35</td>
<td>$54.43</td>
<td>$64.66</td>
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<tr>
<td>Depreciation and amortization</td>
<td>$14.71</td>
<td>$16.00</td>
<td>$17.30</td>
<td>$18.65</td>
<td>$20.07</td>
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<td>Interest expense</td>
<td>$6.75</td>
<td>$6.38</td>
<td>$6.02</td>
<td>$5.69</td>
<td>$5.37</td>
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<tr>
<td>Operating income</td>
<td>$11.78</td>
<td>$14.60</td>
<td>$21.04</td>
<td>$30.09</td>
<td>$39.23</td>
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<td>Operating margin %</td>
<td>3.7%</td>
<td>4.3%</td>
<td>5.8%</td>
<td>7.2%</td>
<td>8.1%</td>
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Population Health Perspective (DSRIP)

Collaboration & Coordination of Care
$350 Million in Funding
Service Demand & Utilization

Risk Stratification & Community Markets
Project Selection: Respiratory Health
Respiratory: Total Hospital IP Activity Hudson Valley (5 Years)

InPatient Discharges

101,000 Discharges
67,700 Unique Patients:

ER Visits (w/o IP Admit)

351,000 ER Visits (w/o IP Admit)
Total Emergency Room Encounters: Respiratory Conditions Hudson Valley, Admitted Patients from ER & Other ER Visits

Highly Seasonalized
Respiratory: Multiple Inpatient & ER Visits/Discharges

24% IP/Resp. Patients with Multiple Visits

29 Exceed 20 Visits

24% ER/Resp. Patients with Multiple Visits

161 Exceed 20 Visits
## Respiratory Conditions: InPatient Discharges

### Hudson Valley (5 Years)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Total 2013</th>
<th>Total 2017</th>
<th>Increase %</th>
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<tr>
<td>122</td>
<td><strong>Pneumonia</strong> <em>(except that caused by tuberculosis or sexually transmitted)</em></td>
<td>30441</td>
<td>188789</td>
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<td>123</td>
<td>Influenza</td>
<td>1060</td>
<td>4475</td>
<td>4.2</td>
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<td>124</td>
<td>Acute and chronic tonsillitis</td>
<td>878</td>
<td>1763</td>
<td>2.0</td>
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<td>125</td>
<td>Acute bronchitis</td>
<td>4956</td>
<td>16878</td>
<td>3.4</td>
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<tr>
<td>127</td>
<td><strong>COPD:</strong> <em>Chronic obstructive pulmonary disease and bronchiectasis</em></td>
<td>19656</td>
<td>113735</td>
<td>5.8</td>
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<tr>
<td>128</td>
<td>Asthma</td>
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<td>58282</td>
<td>4.1</td>
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<tr>
<td>129</td>
<td>Aspiration pneumonitis; food/vomitus</td>
<td>6264</td>
<td>57779</td>
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<td>131</td>
<td>Respiratory failure; insufficiency; arrest (adult)</td>
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<td>112683</td>
<td>10.1</td>
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<td>133</td>
<td>Other lower respiratory disease</td>
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<td>19838</td>
<td>4.7</td>
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<tr>
<td>134</td>
<td>Other upper respiratory disease</td>
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<td>5837</td>
<td>3.7</td>
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<td>126</td>
<td>Other upper respiratory infections</td>
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<td>6794</td>
<td>2.8</td>
</tr>
<tr>
<td>130</td>
<td>Pleurisy; pneumothorax; pulmonary collapse</td>
<td>3677</td>
<td>27659</td>
<td>7.5</td>
</tr>
<tr>
<td>132</td>
<td>Lung disease due to external agents</td>
<td>185</td>
<td>1470</td>
<td>7.9</td>
</tr>
<tr>
<td>1</td>
<td>Tuberculosis <em>(Prod Code 1: Inf Disease</em></td>
<td>237</td>
<td>4859</td>
<td>20.5</td>
</tr>
<tr>
<td>18</td>
<td>Cancer Bronchus or Lung <em>(Prod Code 2: Cancer)</em></td>
<td>853</td>
<td>9665</td>
<td>11.3</td>
</tr>
<tr>
<td>19</td>
<td>Cancer Other Respiratory <em>(Prod Code 2: Cancer)</em></td>
<td>5880</td>
<td>53164</td>
<td>9.0</td>
</tr>
</tbody>
</table>
Hudson Valley View
Project Selection: Respiratory Health
Geo-level of Analysis: Zip Code
Geographic Profile: Respiratory Patients
Geographic Profile: COPD Patients
Geographic Profile: Respiratory Cancer Patients
Geographic Hotspots: Asthma Patients

Asthma Relative Risk

- 2.89 - 6.33
- 1.99 - 2.88
- 1.51 - 1.98
- 1.21 - 1.50
- 1.20

Legend:
- Study Area Counties
- Other NYS Counties
- Other NYS Zip Codes
- Surrounding States
Next Steps

- Define Hotspots for all conditions
- Continue to gather data, information and knowledge from other sources
- Circulate and share all aspects of CNA
- Identify issues and service challenges
- Cross walk DSRIP project selection/plans with CNA findings
Thank You

Discussion & Questions
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