Understanding Emerging Complications and their Implications

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Emerging Complications

• Midas+ Live applies evidence-based research to real-time patient data (e.g., laboratory, radiology, medications, vital signs, etc.) to provide hospital clinicians with actionable views, and early-warning alerts.

• This results in improvements that include avoidable bed days, patient quality outcomes, avoidance of hospital acquired complications, and workflow efficiencies.
Emerging Complications

- Acute Myocardial Infarction (AMI)
- Congestive Heart Failure (CHF)
- Pneumonia
- Stroke
- Catheter-Associated Urinary Tract Infection (CAUTI)
- Central Line-Associated Bloodstream Infection (CLABSI)
- Sepsis
- And more
Importance of Early-Warning Alerts

- **Sepsis** - Each hour of delay in antimicrobial administration is associated with an average decrease in survival of 7.6% (Kumar, 2006).

- **AMI** – 30-day mortality rates are less when PCI performed within 60 minutes vs. 90 minutes from presentation in the emergency room (1.0% vs. 6.4%) (GUSTO-IIb substudy).

- **CLABSI** – The CDC estimates that each CLABSI carries excess health-care costs of $16,550 and mortality of up to 25% (CDC.gov)
Emerging Complications

• A clinically significant emerging complication is evaluated by the clinical team to determine if it is feasible to build out an algorithm using clinical data received from the client.

• The clinical suite of algorithms are re-evaluated on a yearly basis and updated based on the new evidence-based practice guidelines.
Clinical Algorithm Life Cycle

- Research
- Design
- Office of the Medical Director Approval
- Coding
- Testing
- Sensitivity & Specificity Analysis
Qualified vs. Warning

**Qualified**
- Confirmative
- ICD-9 code received
- Diagnosis text string match with keywords
- Uses:
  - Launch Pad views
  - Identifying Core and CQM patients

**Warning**
- Predictive
- Abnormal lab values
- Change in vital signs
- Presence of certain medications
- Uses:
  - Early interventions
  - Better patient outcomes
CVA Qualified References


Enter

Test 1: “Qualified: CVA” exists?

Test 2: ICD-9 code or text string present?

True

Create "Qualified: CVA"

False

False

False
CHF Warning References


Enter

Test 1: "Qualified: CHF" or "Warning: CHF" present?

Test 2: ICD-9 code or text string present?

Test 3: BNP > 200 pg/mL during this encounter?

Test 4: BNP 101-200 pg/mL AND GFR is not < 60 mL/dL during this encounter?

Test 5: Age <50 AND NT-proBNP > 450 pg/ml during this encounter?

Test 6: Age 50-75 AND NT-proBNP > 900 pg/ml during this encounter?

Test 7: Age >75 AND NT-proBNP > 1800 pg/ml during this encounter?

Log Reason: Warning: CHF: Patient has an elevated BNP, date/time stamp

Log Reason: Warning: CHF: Patient has an elevated NT-proBNP, date/time stamp

Create: "Warning: CHF"
CHF Warning (part 1)
CHF Warning (part 2)

- Test 3: BNP > 200 pg/ml during this encounter?
  - False
  - True
- Test 4: BNP 101-200 pg/ml AND GFR is not < 60 mL/dL during this encounter?
  - False
  - True

Log Reason: Warning: CHF: Patient has an elevated BNP, date/time stamp
CHF Warning (part 3)

Test 5: Age <50 AND NT-proBNP > 450 pg/ml during this encounter?

Test 6: Age 50-75 AND NT-proBNP > 900 pg/ml during this encounter?

Test 7: Age >75 AND NT-proBNP > 1800 pg/ml during this encounter?

Log Reason: Warning: CHF: Patient has an elevated NT-proBNP, date/time stamp
CHF Warning (part 4)

Log Reason: Warning: CHF: Patient has an elevated BNP, date/time stamp

Log Reason: Warning: CHF: Patient has an elevated NT-proBNP, date/time stamp

Create: “Warning: CHF”
QC Testing

- Test cases are built to ensure that the algorithm triggers on and off appropriately based on the specific test criteria. Example of CHF Warning:

<table>
<thead>
<tr>
<th>Test Patient ID</th>
<th>CHF Warning</th>
<th>CHF ICD-9 Code Set</th>
<th>CHF Text String set</th>
<th>Age</th>
<th>BNP Value</th>
<th>NT-proBNP Value</th>
<th>GFR Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient1</td>
<td>ON</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Patient2</td>
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<td></td>
<td></td>
<td>101</td>
<td></td>
<td>&quot;&gt;60&quot;</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Patient4</td>
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<td></td>
<td></td>
<td>201</td>
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<tr>
<td>Patient5</td>
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<td></td>
<td>49</td>
<td>451</td>
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<td>59</td>
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<tr>
<td>Patient6</td>
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<td></td>
<td></td>
<td>65</td>
<td>901</td>
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<td></td>
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<tr>
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<td>ON</td>
<td></td>
<td></td>
<td>76</td>
<td>1801</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient8</td>
<td>OFF</td>
<td>404.91 is present</td>
<td></td>
<td>101</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient9</td>
<td>OFF</td>
<td>Y (CHF)</td>
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<td>101</td>
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<td></td>
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</tr>
<tr>
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<td>Patient13</td>
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<td>Patient14</td>
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<tr>
<td>Patient15</td>
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<td></td>
<td>76</td>
<td>1800</td>
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<td></td>
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<tr>
<td>Patient16</td>
<td>OFF</td>
<td></td>
<td></td>
<td>45</td>
<td>1850</td>
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</tr>
</tbody>
</table>
• **Sensitivity** is the ability of an algorithm to correctly identify patients with the disease (true positive rate)

• **Specificity** is the ability of an algorithm to correctly identify patients without the disease (true negative rate)
Statistical Analysis

• If 100 patients known to have a disease were tested, and 43 test positive, then the test has 43% sensitivity. If 100 with no disease are tested and 96 return a negative result, then the test has 96% specificity.

• A highly specific test is unlikely to give a false positive result, so a positive result should be regarded as a true positive.

• A highly sensitive test rarely misses a condition, so a negative result should be reassuring (the disease tested for is absent).
Statistical Analysis

• For any test, there is usually a trade-off between the measures

• For example: in an airport security setting in which one is testing for potential threats to safety, scanners may be set to trigger on low-risk items like belt buckles and keys (low specificity), in order to reduce the risk of missing objects that do pose a threat to the aircraft and those aboard (high sensitivity).
# Sensitivity and Specificity

<table>
<thead>
<tr>
<th>Algorithm Outcome</th>
<th>Condition Positive</th>
<th>Condition Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algorithm Positive</td>
<td>True Positive</td>
<td>False Positive</td>
</tr>
<tr>
<td>Algorithm Negative</td>
<td>False Negative</td>
<td>True Negative</td>
</tr>
</tbody>
</table>

Condition (determined by the “Gold Standard”)

- Positive
- Negative

Sensitivity and Specificity
Analysis Steps for AMI Warning

- Determine Condition Positive and Condition Negative patients by querying the database for a list of patients with final ICD-9 coding that indicate acute myocardial infarction (AMI)
- Determine Algorithm Positive and Algorithm Negative patients by querying the database for a list of patients flagged as “AMI qualified” by Midas+ Live
- Determine the number of true and false positives and the true and false negatives
- Calculate the sensitivity and specificity rates
Sensitivity and Specificity results for the AMI Warning Algorithm

<table>
<thead>
<tr>
<th>AMI Warning Algorithm Outcome</th>
<th>Condition determined by Final ICD-9 Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AMI Positive (n=427)</td>
</tr>
<tr>
<td>AMI Warning Positive (n=1289)</td>
<td>True Positive (n=349)</td>
</tr>
<tr>
<td>AMI Warning Negative (n=10531)</td>
<td>False Negative (n=78)</td>
</tr>
</tbody>
</table>

Sensitivity of 82% (349/427) – Meaning correctly predicted 82% of patients with AMI as having an AMI

Specificity of 92% (10453/11393) – Meaning correctly identified 92% of non-AMI patients as not having an AMI
Thank you for attending.

Questions, anyone?

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