ENHANCING DATA MANAGEMENT FOR ANTIMICROBIAL STEWARDSHIP

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9 May 2019
Al found to be on par with radiologists in diagnosing prostate cancer

An artificial intelligence system developed by UCLA researchers demonstrated comparable results with experienced doctors in reading magnetic resonance imaging scans.

HIT Think Why libraries can become the heartbeat of health information

Americans trust and depend on their local libraries to disseminate factual, credible knowledge.

CMS using data to better monitor nursing home performance

The Centers for Medicare and Medicaid Services is warning nursing homes that it wants to see better care and outcomes and is using data to track progress.

Skilled nursing facilities Joseph Goedert April 16

https://www.healthdatamanagement.com/
Data Management in Medicine

- Receive and process the data
- Validate the data
- Store and protect the data
- Confirm accessibility to the data
- Ensure reliability of the data
- Guarantee timeliness of the data
Technology as Stewardship

- Early Detection
- Rapid Diagnostic Technology
- Patient-specific Data
- Every Patient Tells a Story
- Microorganism Genomics
- Precision Medicine
- Data Science & Machine Learning
- Synthesize Stagnant Data
Mobilizing the Antibiogram

PRE: Web-Based
- Compiled annually by microbiology lab
- Antibiogram available hospital wide on AMS website, printed
- Visited approximately 30 times/month

POST: Mobile Technology
- Updated automatically by ILUM every quarter
- Antibiogram available on web and mobile devices
- Visited approximately 3000 times/month
## Interactive Antibiogram

|                | Amikacin | Amoxicillin + Clavulanic Acid | Ampicillin | Aztreonam | Cefazolin | Cefepime | Ceftriaxone | Ceftazidime | Ceftobiprole | Ciprofloxacin | Clarithromycin | Doripenem | Ertapenem | Gentamicin | Levofloxacin | Meropenem | Nitrofurantoin | Oxacillin | Piperacillin + Tazobactam | Riampin | Tetracycline | Tigecycline | Tobramycin | Trimethoprim + Sulfamethoxazole | Vancomycin |
|----------------|----------|-------------------------------|------------|-----------|-----------|----------|------------|------------|-------------|--------------|---------------|------------|----------|-----------|-------------|------------|----------|----------------|----------|----------------|-------------|----------|----------------|-------------|
| **Enterobacter cloacae** |          |                               |            |           |           |          |            |            |             |              |               |            |          |           |             |            |          |                |          |                |             |          |                |             |
| **Enterococcus faecalis** |          |                               |            |           |           |          |            |            |             |              |               |            |          |           |             |            |          |                |          |                |             |          |                |             |
| **Escherichia coli**     |          |                               |            |           |           |          |            |            |             |              |               |            |          |           |             |            |          |                |          |                |             |          |                |             |
| **Klebsiella oxytoca**   | 100      | 0                             | 62         | 85        | 31        | 85       | 85         | 85         | 100         |              | 100          | 100       | 92        | 100       | 100         | 100       | 100         | 100       | 92            | 92         | 69              | 100       | 92          | 77          |         |
| **Klebsiella pneumoniae**| 100      | 0                             | 82         | 95        | 93        | 96       | 96         | 96         | 88          |              | 100          | 98        | 95        | 91        | 98         | 63        | 93          | 93        | 100           | 82         | 100            | 100       | 93          | 91          |         |
| **Proteus mirabilis**    | 100      | 33                            | 50         | 50        | 42        | 58       | 64         | 58         | 25          |              | 100          | 58        | 25        | 100       | 25         | 100       | 25          | 92        | 0             | 58         | 50              |           |            |             |         |
| **Pseudomonas aeruginosa**|         |                               |            |           |           |          |            |            |             |              |               |            |          |           |             |            |          |                |          |                |             |          |                |             |
| **Staphylococcus aureus**|         |                               |            |           |           |          |            |            |             |              |               |            |          |           |             |            |          |                |          |                |             |          |                |             |

**Percent susceptible**

- **90% +**
- **81 - 90%**
- **71 - 80%**
- **0 - 70%**
Approval for Restricted Antimicrobials

**PRE: Unidirectional pager**

- Lacks required patient fields
- No tracking of medications, indications, requestors, approval ratings
- Often required logging into the EMR
- Phone call to the requestor to approve or deny

**POST: Mobile app + EMR Integration**

- Required patient fields
- Tracks medications, indications, requestors, approval ratings
- Minimal need to log into the EMR
- Automating approval for requestors who have high approval rates for defined antimicrobials and indications
# Approval for Restricted Antimicrobials

<table>
<thead>
<tr>
<th>Ordering Provider</th>
<th># Requests</th>
<th>Indication</th>
<th>Antimicrobial</th>
<th>% Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park, Janie</td>
<td>78</td>
<td>Prophylaxis</td>
<td>Caspofungin</td>
<td>86%</td>
</tr>
<tr>
<td>Allen, Katie</td>
<td>102</td>
<td>Prophylaxis</td>
<td>Fluconazole</td>
<td>90%</td>
</tr>
<tr>
<td>Allen, Katie</td>
<td>109</td>
<td>Prophylaxis</td>
<td>Levofloxacin</td>
<td>78%</td>
</tr>
<tr>
<td>Bange, Aaron</td>
<td>53</td>
<td>Pneumonia</td>
<td>Levofloxacin</td>
<td>90%</td>
</tr>
<tr>
<td>Brinley, Sarah Lee</td>
<td>33</td>
<td>UTI</td>
<td>Levofloxacin</td>
<td>98%</td>
</tr>
<tr>
<td>Decena, Maria</td>
<td>54</td>
<td>Prophylaxis</td>
<td>Voriconazole</td>
<td>100%</td>
</tr>
<tr>
<td>Decena, Maria</td>
<td>54</td>
<td>Prophylaxis</td>
<td>Caspofungin</td>
<td>98%</td>
</tr>
<tr>
<td>Pope, Oliva</td>
<td>141</td>
<td>Prophylaxis</td>
<td>Caspofungin</td>
<td>100%</td>
</tr>
<tr>
<td>Pope, Oliva</td>
<td>141</td>
<td>Prophylaxis</td>
<td>Fluconazole</td>
<td>100%</td>
</tr>
<tr>
<td>Pope, Oliva</td>
<td>141</td>
<td>Prophylaxis</td>
<td>Posaconazole</td>
<td>100%</td>
</tr>
<tr>
<td>Pope, Oliva</td>
<td>141</td>
<td>Prophylaxis</td>
<td>Voriconazole</td>
<td>100%</td>
</tr>
<tr>
<td>Hamilton, Kara</td>
<td>29</td>
<td>Pneumonia</td>
<td>Levofloxacin</td>
<td>78%</td>
</tr>
<tr>
<td>Hamilton, Kara</td>
<td>29</td>
<td>Prophylaxis</td>
<td>Levofloxacin</td>
<td>90%</td>
</tr>
<tr>
<td>Haven, Lindsay</td>
<td>80</td>
<td>UTI</td>
<td>Levofloxacin</td>
<td>60%</td>
</tr>
<tr>
<td>Haven, Lindsay</td>
<td>80</td>
<td>Prophylaxis</td>
<td>Caspofungin</td>
<td>95%</td>
</tr>
</tbody>
</table>
ID Risk Factor Assessment

• Risk factors for ID are known, but meaningful aggregation is missing
• Historically: Manual EMR review for previous infections, susceptibilities, MRSA/Pseudomonas risk factors, allergies
• Unknown: What antimicrobial to use today
• Barriers:
  – Multiple cultures with varying susceptibilities
  – Persistence of resistance
  – Unknown impact of historic antimicrobial exposure
ID Risk Factor Assessment

Step 1
Aggregate and display data that can impact antimicrobial selection

Step 2
Use data in a manual scoring system to perform risk assessment

Step 3
Apply artificial intelligence to the data to perform risk assessment and optimize therapy
### Step 1: Risk Factor Display

**Precision Antibiotic Therapy (PAT)**

PAT is tailored by your antimicrobial stewardship team to your institutional guidelines and formulary to help individualize local practices. Antimicrobials are categorized and ordered according to your stewardship team’s guidance for susceptibility thresholds and then scaled using antibiogram, predicted, and reported susceptibilities. The system evaluates patient-specific data such as the patient’s demographics, location, medication and microbiological results history, trends from similar patients, and local epidemiology to recognize patterns, much like a clinician might recognize similar patients.

<table>
<thead>
<tr>
<th>Positive ID Results</th>
<th>Noteworthy Organisms</th>
<th>Antimicrobials</th>
<th>Hospitalizations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organism</strong></td>
<td><strong>Source</strong></td>
<td><strong>Date</strong></td>
<td><strong>Organism</strong></td>
</tr>
<tr>
<td>E. coli</td>
<td>Blood</td>
<td>02/02/19</td>
<td>MRSA</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>Resp</td>
<td>01/20/19</td>
<td>C. difficile</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>Urine</td>
<td>01/17/19</td>
<td>Amoxicillin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pip-Tazo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ceftriaxone</td>
</tr>
</tbody>
</table>
Step 2: Manual Scoring Systems

- APACHE II (Acute Physiology, Age, Chronic Health Evaluation)
- SIRS (Systemic Inflammatory Response Syndrome) criteria
- Quick Sequential Organ Failure Assessment (qSOFA) score
- Charlson comorbidity index
- Expanded CURB-65

<table>
<thead>
<tr>
<th>Criterion</th>
<th>SIRS</th>
<th>qSOFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body temperature (°C)</td>
<td>&lt;36 or &gt;38</td>
<td>-</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>&gt;90</td>
<td>-</td>
</tr>
<tr>
<td>White blood cell count (10³/μL)</td>
<td>&lt;4 or &gt;12</td>
<td>-</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)</td>
<td>&gt;20</td>
<td>≥22</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>-</td>
<td>≤100</td>
</tr>
<tr>
<td>Glasgow Coma Scale</td>
<td>-</td>
<td>≤13</td>
</tr>
</tbody>
</table>

SIRS: systemic inflammatory response syndrome, qSOFA: quick Sepsis-related Organ Failure Assessment.
Developing a BSI Mortality Risk Score

• **OBJECTIVE**
  - Develop a risk score to predict probability of bloodstream infections (BSIs) due to extended-spectrum β-lactamase-producing *Enterobacteriaceae* (ESBLE)

• **SETTING**
  - Two large community hospitals

• **DESIGN**
  - Retrospective case-control study

• **METHODS**
  - Multivariate logistic regression was used to identify independent risk factors for ESBLE BSI
  - The regression coefficients were then used to allocate points in extended-spectrum β-lactamase prediction score (ESBL-PS)

Bloodstream Infection Mortality Risk Score

**RESULTS**
- 42/910 (4.6%) patients with *Enterobacteriaceae* BSI had ESBL isolates
- The area under the ROC curve for the ESBL-PS model was 0.86
- Using ESBL-PS ≥3 to indicate high risk provided a negative predictive value of 97%

**CONCLUSIONS**
- ESBL-PS estimated patient-specific risk of ESBLE BSI with high discrimination
- Incorporation of ESBL-PS with acute severity of illness may improve adequacy of empirical antimicrobial therapy and reduce carbapenem utilization

<table>
<thead>
<tr>
<th>Point Value</th>
<th>Risk Factor</th>
<th>Score</th>
<th>Probability of ESBL BSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Outpatient procedures within 1 month</td>
<td>0</td>
<td>0.7%</td>
</tr>
<tr>
<td>4</td>
<td>Prior infections or colonization with ESBLE within 12 months</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>1 course: 1 point</td>
<td>Number of courses of β-lactams and/or FQ used within 3 months of BSI</td>
<td>3</td>
<td>24%</td>
</tr>
<tr>
<td>≥2 courses: 3 points</td>
<td></td>
<td>4</td>
<td>44%</td>
</tr>
</tbody>
</table>
Step 3: Automated Tools

Considers patient-specific risk factors and local epidemiology

Creates susceptibility predictions before results are available

Categorization directs clinicians to the best therapy for the patient

Precision Antibiotic Therapy (PAT)
Application of PAT to Patient Care

PAT predictions are as good as or better than antibiogram predictions.

1. Discriminate Enterococcal BSIs susceptible or resistant to vancomycin.

2. Showed lower in-hospital mortality and shorter time to effective antibiotic therapy in drug-resistant and extremely drug-resistant Gram(-) BSIs.

3. PAT predicted susceptibility better than the antibiogram for 81% of clinically meaningful bug-drug combinations.

References:
“The people who are crazy enough to think they can change the world are the ones who do.”

- Steve Jobs

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