CONDUCTING AND EVALUATING ANTIBIOTIC STEWARDSHIP: COMMERCIAL PRODUCTS VERSUS DIY

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DISCLOSURES

- No current financial or other potential conflicts of interest to report
  - Not receiving any financial or other incentives from any commercial product discussed
- Currently funded by NIH KL2RR024141
- Previously involved in evaluation of beta version of Cereplex’s PharmWatch (now Premier’s Safety Surveillor)
  - No affiliation with Premier
- This presentation is for informational purposes; not an endorsement of any product
OBJECTIVES

- Understand how an EMR works behind the scenes
- Identify the challenges in the use of data to facilitate stewardship
- Overview of commercial products
- What is needed to implement home-grown tool
Behind the Scenes of an EMR
# Flat vs. Relational

- **Flat tables**
  - Large & inefficient

<table>
<thead>
<tr>
<th>MRN</th>
<th>Sex</th>
<th>Encounter #</th>
<th>Culture Accession #</th>
<th>Culture Result</th>
<th>Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td>M</td>
<td>3001</td>
<td>001</td>
<td>POS</td>
<td>S. aureus</td>
</tr>
<tr>
<td>1001</td>
<td>M</td>
<td>3001</td>
<td>002</td>
<td>NEG</td>
<td></td>
</tr>
<tr>
<td>1002</td>
<td>F</td>
<td>4001</td>
<td>001</td>
<td>POS</td>
<td>E. coli</td>
</tr>
<tr>
<td>1002</td>
<td>F</td>
<td>5002</td>
<td>001</td>
<td>POS</td>
<td>Enterococcus spp.</td>
</tr>
</tbody>
</table>
**FLAT VS. RELATIONAL**

- **Relational tables**
  - Multiple tables linked by “primary key” fields
    - Similar to MS Access
  - Allows for efficient data storage
  - Thousands of tables associated with an EMR system
    - Documentation/data dictionary
## Relational Tables

<table>
<thead>
<tr>
<th>MRN</th>
<th>Sex</th>
<th>MRN</th>
<th>Encounter #</th>
<th>Admit Date</th>
<th>Discharge Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td>M</td>
<td>1001</td>
<td>3001</td>
<td>1/1/10</td>
<td>1/7/10</td>
</tr>
<tr>
<td>1002</td>
<td>F</td>
<td>1002</td>
<td>4001</td>
<td>2/3/10</td>
<td>2/5/10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1002</td>
<td>5002</td>
<td>3/11/10</td>
<td>3/28/10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Encounter #</th>
<th>Culture Accession #</th>
<th>Culture Result</th>
<th>Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>3001</td>
<td>001</td>
<td>POS</td>
<td>S. aureus</td>
</tr>
<tr>
<td>3001</td>
<td>002</td>
<td>NEG</td>
<td></td>
</tr>
<tr>
<td>4001</td>
<td>001</td>
<td>POS</td>
<td>E. coli</td>
</tr>
<tr>
<td>5002</td>
<td>001</td>
<td>POS</td>
<td>Enterococcus spp.</td>
</tr>
</tbody>
</table>
DATA FORMATS

- Discrete fields
  - Table-type format
  - Fields always ordered the same
  - Each field/variable has a specific format and length
  - Missing data clearly identifiable

- Limited options vs. open/free text
HL7

- Health Level Seven (HL7)
  - Non-profit organization that is involved in the development of healthcare informatics interoperability standards
  - Name also commonly used to refer to the standard

- HL7 standard
  - Widely used format for healthcare data
  - Federally required format/architecture for certain EMR modules
    - CDC NHSN uses this structure
  - Data transfer protocol tags the different data fields
    - Data *not* transferred as a discrete table
    - Allows data to be more easily shared between systems
IMPLEMENTING A HOME-GROWN PRODUCT

- At least 10 FTE of data programmers/analysts initially
- Clinical content experts needed
- Support from administration needed
- Time
- Validation/evaluation
COMMERCIAL PRODUCTS

- Vendors are EMR system agnostic
  - Systems are so customized by location that experience with one system doesn’t transfer to another, etc.
- Pricing plans vary in structure
- Need to make them pitch to you to compare
- They will have data from other institutions to help you justify costs to the administration
- Antimicrobial stewardship tools often integrated with infection control tools
COMMERCIAL PRODUCTS

- All products can identify the major stewardship concerns
  - IV to PO switches
  - Double coverage
  - Dosage adjustments
  - Optimization of therapy
  - Resistance/susceptibility
  - Drug-bug mismatches
- Customizable alerts
- Alerts generally higher sensitivity and imperfect specificity
**MedMined™, CareFusion**

- MedMined™ modules
  - Patient Event Advisor
    - Pharmacy-based system
    - Antibiotic monitoring alerts
  - Virtual Surveillance Infection
    - Supports infection control activities
- Clinical experts support team available
- Generates antibiograms
- Evidence-based alerts pre-programmed
- Customizable alerts by user
- Email alerts to users
- Pyxis is a CareFusion product—can work directly dispensing information
  - Alerts at the dispensing unit
- Also supports non-ID areas
<table>
<thead>
<tr>
<th>Alert Type</th>
<th>Description</th>
<th>Patient</th>
<th>Date/Time</th>
<th>Location</th>
<th>Rounding List</th>
</tr>
</thead>
<tbody>
<tr>
<td>De-escalation</td>
<td>ESCHERICHIA GENUS - URINE - urine; CIPROFLOXACIN;</td>
<td>CFFE3F, 59FQAZKQ, F</td>
<td>10/12/2010 10:22:00 AM</td>
<td>60Q Wvcx, 6070:F</td>
<td>Add Alert</td>
</tr>
<tr>
<td>De-escalation</td>
<td>&gt;100,000 cfu/ml Escherichia coli</td>
<td>urine Test: Urine Culture</td>
<td>10/11/2010</td>
<td>2:</td>
<td>Add Alert</td>
</tr>
<tr>
<td>Non-infection marker with GROUP B STREPTOCOCCUS</td>
<td></td>
<td></td>
<td></td>
<td>3:</td>
<td>Add Alert</td>
</tr>
<tr>
<td>Vancomycin Level</td>
<td>VANCOMYCIN TROUGH = 8.9 mg/l</td>
<td>QUOQ, CFVKQF, X</td>
<td>10/12/2010 10:01:00 AM</td>
<td>CQX KCU, CC67:F</td>
<td>Add Alert</td>
</tr>
<tr>
<td>Non-infection marker with GROUP B STREPTOCOCCUS</td>
<td></td>
<td>GKEGQW, ZFVO</td>
<td>10/12/2010 0:44:00 AM</td>
<td></td>
<td>Add Alert</td>
</tr>
</tbody>
</table>
Days of therapy per 1,000 patient days

Number of months

Baseline 1 2 3 4 5 6 7 8 9

Doripenem
Tigecycline
SAFETY SURVEILLOR™, PREMIER, INC.

- Integrated stewardship and infection control module
- Available as an individual module
- Customizable work lists by user
- Can be used to generate antibiograms
  - Specific to user-designated time frames and units
- Includes some ability for evaluation
- Includes access to training modules, internal marketing, cost justification letters, etc.
  - For additional fee for access to training modules though DICON
SAFETY SURVEILLOR™
Pharmacy Intervention Adherence

Interventions

Pharmacy Interventions by Type

Interventions

Total Intervention Count = 384
Sentri7™, Pharmacy OneSource

- **Sentri7™**
  - Started as a tool for documenting pharmacy interventions
  - Now expanded: supports stewardship, infection control, and others
  - Relies on user-specified queries/reports
  - Institution can specify recommended actions
  - Creates institution-specific, rolling annual antibiograms
  - Web-based, data stored on off-site server
### Carbapenems, Vancomycin or Linezolid & Final Cult. (1)

<table>
<thead>
<tr>
<th>Patient Id</th>
<th>Name</th>
<th>Location</th>
<th>Events in Last 7 Days</th>
<th>Culture-Blood</th>
<th>Culture-Wound, Deep</th>
<th>Drug Matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>XY07461</td>
<td>Smith, John</td>
<td>S40 - 02</td>
<td>Specimen Source Blood</td>
<td>Specimen Source Foot...</td>
<td>VANCOMYCIN</td>
<td>1/1</td>
</tr>
</tbody>
</table>

**Suggested Action:**
- Convert to narrower spectrum antibiotic if appropriate.
- See antimicrobial de-escalation guide [HERE](#).

### MDRO Culture Positive (MRSA, C.Diff, VRE, KPC) (1)

<table>
<thead>
<tr>
<th>Patient Id</th>
<th>Name</th>
<th>Location</th>
<th>Events in Last 7 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>XY00064</td>
<td>Doe, Jane B</td>
<td>120 - 01</td>
<td></td>
</tr>
</tbody>
</table>

**Suggested Action:**
- See C. Diff treatment algorithm [HERE](#).

### Enterococcus Positive, Vanco Sens, on Zyvox (1)

<table>
<thead>
<tr>
<th>Patient Id</th>
<th>Name</th>
<th>Location</th>
<th>Events in Last 7 Days</th>
<th>Drug Matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>XY07461</td>
<td>Smith, John</td>
<td>S40 - 02</td>
<td>Specimen Source Blood</td>
<td></td>
</tr>
</tbody>
</table>

**Suggested Action:**
- Convert to narrower spectrum antibiotic if appropriate.
- See antimicrobial dosing guide [HERE](#).

### Drug Bug Mismatch: Vanc Resistant, on Vancomycin (1)

<table>
<thead>
<tr>
<th>Patient Id</th>
<th>Name</th>
<th>Location</th>
<th>Events in Last 7 Days</th>
<th>Drug Matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>XY00012</td>
<td>CASSO, Mike P</td>
<td>360 - 01</td>
<td>Specimen Source Blood</td>
<td></td>
</tr>
</tbody>
</table>

**Suggested Action:**
- Patients have documented resistance to Vancomycin on final C&S AND have a current active order for IV Vancomycin.
- Consider switching to alternative such as Tigecycline.
- Document intervention in QuantiSt.

### E. Coli Streamlining (1)

<table>
<thead>
<tr>
<th>Patient Id</th>
<th>Name</th>
<th>Location</th>
<th>Events in Last 7 Days</th>
<th>Drug Matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>XY00064</td>
<td>Doe, Jane B</td>
<td>120 - 01</td>
<td>Specimen Source Blood</td>
<td></td>
</tr>
</tbody>
</table>

**Suggested Action:**
- E. Coli in blood or urine that is sensitive to Cefazolin and patient is on broad spectrum therapy like a carbapenem, Zosyn, Unasyn, Timentin, quinolone should be converted to cefazolin per policy.

### MSSA Streamlining (1)

<table>
<thead>
<tr>
<th>Patient Id</th>
<th>Name</th>
<th>Location</th>
<th>Events in Last 7 Days</th>
<th>Drug Matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>XY08684</td>
<td>Doe, Jane B</td>
<td>120 - 01</td>
<td>Specimen Source Blood</td>
<td></td>
</tr>
</tbody>
</table>

**Suggested Action:**
- Final culture positive for MSSA and patient is on MRSA drug (Vanco, Zyvox, Cubicin, Tygacil, Synercid) Potential to convert to formulary anti-staph penicillin should be considered.

### VRE and on Vancomycin (1)

<table>
<thead>
<tr>
<th>Patient Id</th>
<th>Name</th>
<th>Location</th>
<th>Events in Last 7 Days</th>
<th>Drug Matches</th>
</tr>
</thead>
</table>

**Suggested Action:**
- See C. Diff treatment algorithm [HERE](#).
TheraDoc, Hospira

- Part of Clinical Intelligence Platform™
- Antibiotic Assistant™
  - Integrated ability to track trends, document interventions
  - Resource for evidence based recommendations
  - Out of box evidence-based alerts included
  - Customizable by individual user
- Infection Control Assistant™
- Pager/Email alerts
- Generates antibiograms
  - Unit, source, time frame specific
  - Users with permission can drill-down for more data
- Data stored in on-site server
- Other, non infectious disease specific modules available
**THERADOC**

<table>
<thead>
<tr>
<th>Alert Time</th>
<th>Alert</th>
</tr>
</thead>
<tbody>
<tr>
<td>02/25/2008 18:32</td>
<td>TAM Alert: Organism not covered by current antimicrobial therapy</td>
</tr>
</tbody>
</table>

**Admit Diagnosis:** DIABETES RENAL FAILURE

**Alert organism(s):**
- URINE CULTURE: Enterobacter cloacae

**Current antimicrobial therapy:**
- GATIFLOXACIN 200 MG IV 24H (02/20/2008 21:00)

**Specimen source:** Urinary catheter specimen
- Collected: 02/17/2008 14:50:00

**Enterobacter cloacae (Acc#: 9391195340)**

<table>
<thead>
<tr>
<th>Tested</th>
<th>Interpretation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>amoxicillin-clavulanate</td>
<td>RESIST</td>
<td>&gt;= 32</td>
</tr>
<tr>
<td>ampicillin</td>
<td>RESIST</td>
<td>&gt;= 32</td>
</tr>
<tr>
<td>cefazolin</td>
<td>RESIST</td>
<td>&gt;= 32</td>
</tr>
<tr>
<td>cefoxitin</td>
<td>RESIST</td>
<td>&gt;= 32</td>
</tr>
<tr>
<td>ciprofloxacin</td>
<td>RESIST</td>
<td>&gt;= 4</td>
</tr>
<tr>
<td>gentamicin</td>
<td>SUSCEPT</td>
<td>&lt;= 0.5</td>
</tr>
<tr>
<td>levofloxacin</td>
<td>RESIST</td>
<td>&lt;= 8</td>
</tr>
<tr>
<td>nitrofurantoin</td>
<td>SUSCEPT</td>
<td>&lt;= 32</td>
</tr>
<tr>
<td>sulfamethoxazole-trimethoprime</td>
<td>SUSCEPT</td>
<td>&lt;= 10</td>
</tr>
<tr>
<td>ticarcillin</td>
<td>SUSCEPT</td>
<td>&lt;= 16</td>
</tr>
<tr>
<td>tobramycin</td>
<td>SUSCEPT</td>
<td>&lt;= 10</td>
</tr>
</tbody>
</table>

**Microbiology Review**
- Laboratory Review
- Consult Abx Wizard
- Medication Profile
- Urinalysis Review
- Radiology Review
Combined Medical-Surgical major teaching

**Criteria**
- BSI: Central-line associated
- NHSN 10
- NHSN 90
- NHSN mean

**Infection Rate**
- 0
- 5
- 10
- 15
- 20
- 25

Dates:
- 2/2/2009
- 3/2/2009
- 4/2/2009
- 5/2/2009
- 6/2/2009
- 7/2/2009
- 8/2/2009
- 9/2/2009
- 10/2/2009
- 11/2/2009
- 12/2/2009
- 1/2/2010
- 2/2/2010
Vecna, QC Pathfinder

- Pharmacy and Infection Control component
  - Typically bundled
- Pricing based on number of data feeds, facilities, etc.
  - Unlimited number of users allowed
- Can store data on remote or on-site server
- Includes pre-programmed alerts and customizable
- Reports can be created by tech support or user
  - Convertible to alert
- E-mail alerts (can be sent to pagers)
- Support includes technical, functional, and clinical
- Customizable, real-time antibiograms
- Rolling out into VA healthcare system starting Fall 2011
- Future development
  - Advanced reporting capabilities using additional “logical” algorithms
  - Mobile interface—some users now using an iPad version
## Pharmacy Interventions Requiring Action

<table>
<thead>
<tr>
<th>Intervention(s) Performed</th>
<th>Medical Record Number</th>
<th>Name</th>
<th>Date Created</th>
<th>Latest Activity Type</th>
<th>Latest Date Updated</th>
<th>Latest Intervening User</th>
<th>Total Time Spent</th>
<th>Estimated Cost Saving</th>
<th>Latest Comment</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug-disease Interaction</td>
<td>MRN 42782432</td>
<td>Harris, Cooper</td>
<td>06/07/2011 15:25</td>
<td>Initiated replacement therapy</td>
<td>06/07/2011 15:25</td>
<td>Practitioner, Infection Control</td>
<td>0</td>
<td>0</td>
<td>Pharmacy Orders Added. Prescription number 42792274 for drug Lansoprazole 30 mg EC capsule Lab Tests Added: Lab Test 110790011142-2011-03-30, Specimen Type Stool Ordered Test Ag C diff Organism Clostridium difficile</td>
<td>VOID INTERVENTION</td>
</tr>
<tr>
<td>Adverse Drug Event</td>
<td>MRN 2319638</td>
<td>Simpson, Caden</td>
<td>06/17/2011 11:53</td>
<td>Administered antidote/reversal or rescue drug</td>
<td>06/29/2011 15:59</td>
<td>Duncan, Kondall</td>
<td>0</td>
<td>0</td>
<td></td>
<td>VOID INTERVENTION</td>
</tr>
</tbody>
</table>

## Pharmacy Interventions Requiring Analysis

<table>
<thead>
<tr>
<th>Intervention(s) Performed</th>
<th>Medical Record Number</th>
<th>Name</th>
<th>Date Created</th>
<th>Latest Activity Type</th>
<th>Latest Date Updated</th>
<th>Latest Intervening User</th>
<th>Total Time Spent</th>
<th>Estimated Cost Saving</th>
<th>Latest Comment</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug Bug Mismatch</td>
<td>MRN 4030445</td>
<td>Vasquez, Cayden</td>
<td>04/14/2011 15:17</td>
<td>Initiated replacement therapy</td>
<td>05/29/2011 16:00</td>
<td>Sullivan, Lucas</td>
<td>0</td>
<td>0</td>
<td>Pharmacy Orders Added. Prescription number 43223451 for drug Piperacillin tazobactam 3.375g/NS 500mL (Acudose) Lab Tests Added: Lab Test 1108600967-2011-03-30, Specimen Type Trach Asp Ordered Test Cuf Resp + Gm Organism Escherichia coli</td>
<td>VOID INTERVENTION</td>
</tr>
</tbody>
</table>

## My Surveillance

To create a new monitor, first specify the parameters by using the "Create Report" feature or by editing an existing report. Next, select a chart to monitor, and click "Save or Update Report/Monitor" at the bottom of the chart. Finally, name the report, check "enable monitoring" checkbox, and select the users to notify when a new alert is generated.
**Patient**
- **Name:** Hans Cooper
- **Medical Record number:** MRN 42782432
- **Date of Birth:**
- **Current Location:** loc110450
- **Gender:** Female
- **Race:**
- **Admission Date:** 03/20/2011 17:30
- **Discharge Date:**

**Intervention Details**

**Drug-disease interaction**
- **Created by:** log, on 06/07/2011 10:24
- **Last updated by:** log, on 06/07/2011 15:25
- **Status:** Requires Action
- **Monitors:**
- **TPRF Report Users**
- **Total time spent:** 0 minutes
- **Estimated cost saving:** 0 dollars

**Summary of Associated Clinical Results**

**Pharmacy Orders**
- **This list contains a beginning pharmacy order and any medication changes that were made as a result of Pharmacy Intervention Activities.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Prescription #</th>
<th>Order Date</th>
<th>Drug</th>
<th>Dosage Size</th>
<th>Dosage Unit</th>
<th>Route</th>
<th>Provider</th>
<th>Last Order Control</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning Pharmacy Order</td>
<td>Prescription 42792274</td>
<td>03/20/2011 10:24</td>
<td>Lansoprazole 30 mg EG capsule</td>
<td>30.00 mg</td>
<td>PO</td>
<td>Webb, Damian</td>
<td>New order</td>
<td><a href="#">Details</a></td>
<td></td>
</tr>
</tbody>
</table>

**Lab Tests**
- **This list contains all lab results that are associated with the Pharmacy Intervention**

<table>
<thead>
<tr>
<th>Specimen ID</th>
<th>Collection Date</th>
<th>Organism</th>
<th>Ordered Test</th>
<th>Additional Info</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>11079001142-2011-03-20</td>
<td>03/20/2011 12:30</td>
<td>Clostridium difficile</td>
<td>Ag C diff</td>
<td><a href="#">Details</a></td>
<td></td>
</tr>
</tbody>
</table>

**Intervention History**

**Initiated replacement therapy** *(Intervention Accepted)*
- **Intervening user:** Practitioner, Infection Control
- **Time of Intervention Activity:** 06/07/2011 15:24
- **Time spent:** 0 minutes
- **Provider:** Webb, Damian
- **Comment:** replaced by another drug
- **Resulting Pharmacy Orders:** None specified

**Pharmacy Orders Added:** Prescription number Prescription 42792274 for drug Lansoprazole 30 mg EG capsule
**Lab Tests Added:** Lab Test 11079001142-2011-03-20, Specimen Type Stool Ordered Test Ag C diff Organism Clostridium difficile

**Activity**
- **Initiated replacement therapy** *(Intervention Accepted)*
- **Log Intervention Progress**
- **Record new activities or comments as you preform work on the Intervention. New activities and comments will be added to the Intervention Activity Log.**
- **Add or remove pharmacy orders and lab tests that initiated this intervention.**
- **Select Pharmacy Orders**
- **Select Lab Tests**
- **Add New Activity**
- **Add New Comment**

**Comment**
- **Pharmacy Orders Added:** Prescription number Prescription 42792274 for drug Lansoprazole 30 mg EG capsule
- **Lab Tests Added:** Lab Test 11079001142-2011-03-20, Specimen Type Stool Ordered Test Ag C diff Organism Clostridium difficile

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- **Pharmacy Orders Added:** Prescription number Prescription 42792274 for drug Lansoprazole 30 mg EG capsule
- **Lab Tests Added:** Lab Test 11079001142-2011-03-20, Specimen Type Stool Ordered Test Ag C diff Organism Clostridium difficile
POINTS IN WHICH PRODUCTS VARY

- Pricing
- Underlying knowledge base used in alerts
- Specificity of alerts
- Amount of historical/patient-level data directly accessible
- Availability of other ID/non-ID products
- Training & Support
  - IT
  - Clinical
- Pre-programmed queries
- Pager/Email alerts
- Reports for evaluation and tracking
- Documentation for internal “marketing”
Evaluation is Key

- Evaluation is important
  - Justifies expense
  - Ensures positive impact on patient care
  - May identify areas for improvement

- Need to understand the data structure/availability to perform meaningful evaluations
  - Limitations in your data
  - How changes in microbiology systems, pharmacy systems, etc., may change the data
  - Source of data for clinical support tool
    - Is it really real time?
  - May want to evaluate things other than pharmacy/microbiology data
    - FTE, $, clinical outcomes, etc.
**EVALUATION IS KEY**

- Plan ahead
  - Randomization?
  - Quasi-experimental? (before and after)
- What analysis you want to perform will guide data collection
- Just quality assessment? Or is it research?
  - Generalizability is key