Leveraging Technology and Informatics for Antimicrobial Stewardship

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Associate Director, Antimicrobial Stewardship Program
The Johns Hopkins Hospital (JHH)
Baltimore, MD
Disclosure

All planners, presenters, and reviewers of this session report no financial relationships relevant to this activity.
Learning Objectives

• List antimicrobial stewardship tools available in electronic health record (EHR) platforms.

• Describe how the EHR and clinical decision support systems (CDSS) can be used together as a successful antimicrobial stewardship tool.

• Review commonly used CDSS and their role in enhancing antimicrobial stewardship.
Introduction

• Electronic health records (EHR) and Clinical Decision Support Systems (CDSSs)
• EHR: Epic System Corporation and Cerner Corporation
  – Largest U.S. market share
• Add-on CDSSs
  – Used for many years for antimicrobial stewardship and infection control activities
  – Enhance quality of care and improve patient outcomes

Antimicrobial Stewardship

- Antimicrobial Stewardship (AS)
  - “Coordinated interventions designed to improve and measure the appropriate use of antibiotic agents by promoting the selection of the optimal antibiotic drug regimen including dosing, duration of therapy, and route of administration”

- Antimicrobial Stewardship Programs (ASP)
  - Programs dedicated to improving antimicrobial use

Implementing an Antibiotic Stewardship Program: Guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America


• Leadership Commitment
• Accountability
• Drug Expertise
• Tracking
• Reporting
• Education

New Antimicrobial Stewardship Standard

Applicable to Hospitals and Critical Access Hospitals

Effective January 1, 2017

Medication Management (MM)

Standard MM.09.01.01
The [critical access] hospital has an antimicrobial stewardship program based on current scientific literature.

Note: An example of an educational tool that can be used for patients and families includes the Centers for Disease Control and Prevention’s Get Smart document, “Viruses or Bacteria—What’s got you sick?” at http://www.cdc.gov/getsmart/community/downloads/getsmart-chart.pdf.

4. The [critical access] hospital has an antimicrobial stewardship multidisciplinary team that includes the following members, when available in the setting:
   ● Infectious disease physician

https://www.jointcommission.org/assets/1/6/HAP-CAH_Antimicrobial_Prepub.pdf;
accessed 9/25/17
Two options: **Antimicrobial use (AU)** and Antimicrobial resistance (AR)

Voluntarily reporting to National Healthcare Safety Network (NHSN)

**Purpose:** facilitate risk adjusted inter- and intra-facility benchmarking of antimicrobial usage

**Metrics:** days of antimicrobial therapy (DOT)/ 1000 days present

**Data Source:** e-MAR and/or bar coding medication record (BCMA)

**Format:** Health Level (HL7) Clinical Document Architecture

ASP and Information Technology

IDSA guidelines

• Incorporate computerized CDSS at the time of prescribing into ASPs

CDC core elements

• Tracking: monitoring antibiotic prescribing and resistance patterns

Joint Commission standard

• Hospital collects, analyzes, and reports data on its ASP

Impact of CDSS on Antibiotic Use

- Reduced use of broad spectrum antibiotics
- Improved antibiotic selection and dosing
- Fewer prescribing errors and adverse events
- Decrease in antibiotic costs and length of stay

Audience Poll

How many of you currently use or plan to use one of these electronic systems for antibiotic stewardship?

A. EHR only
   • EPIC
   • Cerner
   • Other (Meditech or homegrown)

B. Add-on CDSS (non-EHR based)

C. Both A and B

D. Other
Audience Poll

• What is your current role?
  A. Antimicrobial stewardship or ID pharmacist
  B. Informatics/IT pharmacist
  C. Administrative (including Director or VP of Pharmacy)
  D. Pharmacy student or resident
  E. Other
Single Electronic Health Record: Customizing Epic for Antimicrobial Stewardship

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• Review commonly used clinical decision support systems (CDSSs) and their role in enhancing antimicrobial stewardship.

• Describe how both EHR and CDSS can be used together as a successful antimicrobial stewardship tool.
Epic EHR System

• One of the leading providers of EHR systems in U.S.
• 25.8% of the U.S. acute care hospital market share in 2016
• Fully integrated system incorporating all areas of patient care into a single database
• Primary focus on clinical functionality and patient care

Antimicrobial Stewardship Tools

Entry level tools
- iVents
- Order panels and order sets
- IV to PO algorithms
- Order form and dose-checking
- Best practice advisories
- Patient scoring and monitoring
- 96-hour stop date
- Antibiotic indications

Advanced tools
- Epic 2014 and 2016 version
- Available at additional cost
- AS module (Willow)
- Infection control module (ICON)

Antimicrobial Stewardship Module

- **AS Dashboard**
  - Organizes all AS tools in one place

- **AS Scoring System**
  - Identifies patients for AS interventions
  - Allows easy documentation and communication

- **iVents**
  - Documentation of AS interventions
  - Integrated into AS dashboard
  - Allows for easy copy/paste into progress notes
ICON Module

• Enhances infection control activities
• Antibiotic use reports
  – Days of therapy (DOT)/1000 patient days present calculation using e-MAR data
  – Option to submit to NHSN-AUR module
• Workbench reporting
  – Real-time antibiogram reporting
The Johns Hopkins Health System

• Academic hospitals
  – The Johns Hopkins Hospital- 1,194 beds
  – Johns Hopkins Bayview Medical Center- 440 beds
  – Johns Hopkins All Children's (not using Epic)- 259 beds

• Community hospitals
  – Howard County General Hospital- 282 beds
  – Sibley Memorial Hospital- 318 beds
  – Suburban Hospital- 222 beds

• Epic was implemented at 5 hospitals
The Johns Hopkins Hospital AS Program

- Adult inpatients - 2002
- Pediatric inpatients - 2012
- CDDS
  - Theradoc® ~ 15 years
  - Epic AS and ICON module - 2016

Stewardship Interventions
- Pre-authorization
- Prospective audit and feedback
- Syndrome interventions
- Rapid diagnostics interventions
- Pharmacy-driven interventions
- Guidelines for antibiotic use

Metrics
- DOT/1000 patient days present
Customization of AS Module

• AS module was developed by academic hospitals AS teams
• We started with a wish list
  – Patient identification
    • Scoring system (customized rules) vs. workbench reports
  – Documentation of AS interventions
    • AS interventions types and subtypes (iVents)
  – Indications requirement for select antibiotics
• Weekly calls with Epic build team for 1 year
## Customized Rules

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Rules</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX AMS DE-ESCALATION EXISTS</td>
<td>RX AMS DE-ESCALATION ENTEROCOCCUS SUSCEPTIBLE TO AMPICILLIN</td>
<td>5</td>
<td>Flag patients with Enterococcus faecalis spp in blood susceptible to ampicillin who are on vancomycin or linezolid (limit to blood cultures from last 5 days).</td>
</tr>
<tr>
<td></td>
<td>RX AMS DE-ESCALATION MSSA (IN BLOOD) VANC SCORING</td>
<td>5</td>
<td>Flag patients with MSSA (methicillin/oxacillin susceptible staph aureus) in blood and on vancomycin (IV) (limit to cultures from last 5 days).</td>
</tr>
<tr>
<td></td>
<td>RX AMS DE-ESCALATION MICAFUNGIN</td>
<td>3</td>
<td>Flag patients who are on micafungin and have positive blood cultures for candida that is susceptible to fluconazole.</td>
</tr>
<tr>
<td></td>
<td>RX AMS DE-ESCALATION MSSA (NON BLOOD) VANC SCORING</td>
<td>3</td>
<td>Flag patients who are on vancomycin and have MSSA isolated from non-blood cultures. (lower score for non-blood)</td>
</tr>
<tr>
<td>RX AMS RESTRICTED ABX OUTSIDE TIMEFRAME (SCORING SYSTEM)</td>
<td>RX AMS RESTRICTED ABX OUTSIDE TIMEFRAME</td>
<td>5</td>
<td>Flags patients with open i-vents for overnight restricted antimicrobials</td>
</tr>
<tr>
<td>RX AMS PRELIMINARY POSITIVE BLOOD CULTURE</td>
<td>RX AMS PRELIMINARY POSITIVE BLOOD CULTURE</td>
<td>5</td>
<td>Flags patients with preliminary positive blood cultures within the last 5 days.</td>
</tr>
<tr>
<td>RX AMS THERAPEUTIC DRUG MONITORING</td>
<td>RX AMS THERAPEUTIC DRUG MONITORING</td>
<td>3</td>
<td>Flags patients with TDM for the following antimicrobials within the last 3 days; Voriconazole, Itraconazole, Posaconazole, 5FC, Vancomycin, Tobramycin, Amikacin, and Gentamycin</td>
</tr>
<tr>
<td>RX AMS VERIGENE</td>
<td>RX AMS VERIGENE</td>
<td>5</td>
<td>Flags patients with preliminary positive blood cultures that have Verigene identifications available within the past 3 days.</td>
</tr>
<tr>
<td>Standard AS columns</td>
<td>Customized alerts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMS Score</td>
<td>AMS Score Change</td>
<td>AMS Score Review</td>
<td>AMS M vents</td>
</tr>
<tr>
<td>14</td>
<td>18 hrs 53 mins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>0 hrs 0 mins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>0 hrs 4 mins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>Never reviewed</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>20 hrs 29 mins</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>Never reviewed</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>4 hrs 29 mins</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Temp/WBC Trend (Last 5 days)*

<table>
<thead>
<tr>
<th>Temp (°C)</th>
<th>White Blood Cell Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>39.6</td>
<td>10.88</td>
</tr>
</tbody>
</table>

*Anti-Infectives*

- ceFEPIme (MAXIPIME) 1 g/50 mL iso-osmotic (w/ dextrose) Premix

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Stewardship Report

Infection Monitoring

Temp/WBC Trend (Last 7 days)

- Temp (°C):
  - 38.5 (09/07 07:01 - 09/14 09:57)

- White Blood Cell Count:
  - 23.3 (09/07 07:01 - 09/14 09:57)

24h Max:
- 36.6 (97.9) 09/13 2021

Most Recent:
- 23.30 09/13 15:59

Anti-Infectives

- cefTRIAxone (ROCEPHIN) 1 g/50 mL iso-osmotic (w/ dextrose) Premix
  - Dose/Rate, Route, Frequency: 1 g, IV, Once
  - Last Action: Ordered

- cefTRIAxone (ROCEPHIN) 2 g/50 mL iso-osmotic (w/ dextrose) Premix
  - Dose/Rate, Route, Frequency: 2 g, IV, Q12H
  - Last Action: New Bag/Given 09/14 06:36

Antimicrobial Stewardship: 20

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Documentation in Scoring System

Not a part of medical record
Documenting Interventions

Not a part of medical record

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Report: AS I-vents

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Days of antimicrobial therapy (DOT) / 1,000 patient-days present
  – Followed CDC NHSN guidelines
  – Provided specs for customized reports
Reporting to NHSN AUR module requires extensive validation
Antibiograms
  – Clinical Laboratory Standards Institute antibiogram rules
  – List of existing antibiograms for each hospital
- DOTs/1000 patient days present
- Reported by drug class
- Can add customized drugs/locations

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<table>
<thead>
<tr>
<th>Location</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>MTD</th>
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<tbody>
<tr>
<td>Doripenem</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Intravenous route</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ertapenem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intravenous route</td>
<td>5.00</td>
<td>4.00</td>
<td>4.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Imipenem with Cilastatin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intravenous route</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Meropenem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intravenous route</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

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Graphic Display
Single Agent, Single Unit

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Antibiogram Reporting

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Extraction of Data

• Data from Epic can be extracted only in Excel format
• We used Tableau to build AS Dashboards
  – Allows more user customization in real time
  – Fast analytics
  – Easy to use and share
  – Automatic updates
  – User customization
  – Allowed us to get more than DOT/1000 patient days

https://www.tableau.com/; accessed 9/25/17
Tableau Report: DOT/1000 Patient Days Present

Day of Therapy per 1000 Days Present Trend

Medical Ward

Medical Ward

ICU

Surgical Ward

ICU

Surgical Ward

<table>
<thead>
<tr>
<th>Year</th>
<th>Medical Ward</th>
<th>Medical Ward</th>
<th>ICU</th>
<th>Surgical Ward</th>
<th>ICU</th>
<th>Surgical Ward</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 Q3</td>
<td>37</td>
<td>30</td>
<td>28</td>
<td>183</td>
<td>72</td>
<td>60</td>
</tr>
<tr>
<td>2016 Q4</td>
<td>40</td>
<td>34</td>
<td>30</td>
<td>155</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>2017 Q1</td>
<td>30</td>
<td>27</td>
<td>28</td>
<td>191</td>
<td>57</td>
<td>54</td>
</tr>
<tr>
<td>2017 Q2</td>
<td>30</td>
<td>28</td>
<td>28</td>
<td>138</td>
<td>56</td>
<td>50</td>
</tr>
<tr>
<td>2017 Q3</td>
<td>40</td>
<td>29</td>
<td>28</td>
<td>62</td>
<td>42</td>
<td>24</td>
</tr>
<tr>
<td>2017 Q4</td>
<td>32</td>
<td>30</td>
<td>28</td>
<td>115</td>
<td>69</td>
<td>113</td>
</tr>
<tr>
<td>2018 Q1</td>
<td>33</td>
<td>31</td>
<td>28</td>
<td>217</td>
<td>71</td>
<td>125</td>
</tr>
<tr>
<td>2018 Q2</td>
<td>33</td>
<td>32</td>
<td>28</td>
<td>218</td>
<td>71</td>
<td>125</td>
</tr>
<tr>
<td>2018 Q3</td>
<td>33</td>
<td>33</td>
<td>28</td>
<td>219</td>
<td>71</td>
<td>125</td>
</tr>
<tr>
<td>2018 Q4</td>
<td>33</td>
<td>34</td>
<td>28</td>
<td>218</td>
<td>71</td>
<td>125</td>
</tr>
</tbody>
</table>

ashp75

CELEBRATING 75 YEARS
Tableau Report: Duration of Therapy

**Median Duration of Therapy Breakdown by Antimicrobial**

Duration is segregated per Admission & Antimicrobial - Encounters Level Data

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>Median Duration (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEROPENEM</td>
<td>3.54</td>
</tr>
<tr>
<td>PIPERACILLIN-TAZOBACTAM</td>
<td>2.96</td>
</tr>
<tr>
<td>CEFEPIME</td>
<td>1.96</td>
</tr>
<tr>
<td>VANCOMYCIN-IV</td>
<td>1.96</td>
</tr>
</tbody>
</table>
Impact on Clinical Outcomes

• 1 study reviewed iVents documentation by ASP
  – AS interventions resulted in decrease in antibiotic use
  – Easy documentation allowed ASP to demonstrate their impact

• 1 study integrated CDSS with Epic
  – Decrease in use of all antibiotics, ant-MRSA and anti-pseudomonal agents

Barriers and Challenges

• Resources for implementation and maintenance
  – Costs of software and hardware
  – IT personnel
  – Time to develop, build, test
• Administrative, ethical, legal issues
  – Electronic alerts can result in premature antibiotic discontinuation
• Excessive alerts - “alert fatigue”

Which of the following AS tools are available in Epic?

A. Real-time antibiogram reporting
B. Identification of patients for AS interventions
C. Days of therapy (DOT)/1000 patient days present metric
D. All of the above
Enhancing ASP Activities: Patient Lists

✓ Prospective audit and feedback – real time alerts
  ✓ Bug and drug
  ✗ Diseases based (e.g., community-acquired pneumonia)
  ✓ Customizable

✓ Treatment guidelines- order sets
✓ Entry level AS tools
Enhancing ASP Activities: Reports

- ✓ Antibiograms
  - ✓ Real time
  - ✓ Some user customization in real time
- ✓ Antibiotic use data - DOT/1000 patient days present
  - ✓ Real time - graphs and tables
  - ❌ User customization in real time
- ✓ NHSN AUR reporting
- ❌ Patient outcomes tracking in real time
- ✓ Prescriber metrics and patient outcomes data
How to Make Customization Successful

- Presence of and leadership by AS team
  - Experience of AS team in performing AS interventions
  - Be prepared! Have a wish list! Dedicate your time to this up front!
  - Don’t give up easily when encountering barriers
  - Make sure to test your alerts before go-live

- Dedicated IT resources upfront
  - Have someone with microbiology background if possible

- Community hospitals- partner with other hospitals within health-system
Key Takeaways

• Key Takeaway #1
  – Epic AS module can increase effectiveness and efficiency of ASP personnel

• Key Takeaway #2
  – Implementation can be costly and resource demanding upfront

• Key Takeaway #3
  – Single EHR record and customizable alerts allows for adaptation by many users
Acknowledgements

• The Johns Hopkins Hospital ASP team
  – Sara Cosgrove, MD, MS
  – Kate Dzintars, PharmD, BCPS, AQ-ID
  – Alice Hsu, PharmD, BCPS, AQ-ID
  – Pranita Tamma, MD, MHS

• Johns Hopkins Bayview Medical Center ASP team
  – Victoria Adams-Sommer, PharmD, BCPS, AQ-ID
  – Jennifer Townsend, MD

• Hopkins Epic IT team
  – Amanda Miller, BS, M(ASCP)CM
  – Nicole Mudassar, MLS (ASCP)
Optimizing “Add on” Clinical Decision Support Systems for Antibiotic Stewardship

Kristi Kuper, Pharm.D., BCPS
Sr. Clinical Manager, ID
Vizient
Houston, TX
Learning Objectives

• List antimicrobial stewardship tools available in electronic health record (EHR) platforms.

• Review commonly used clinical decision support systems (CDSS) and their role in enhancing antimicrobial stewardship.

• Describe how both EHR and CDSS can be used together as a successful antimicrobial stewardship tool.
In the Beginning, there was....

• HELP – Health Evaluation through Logical Processing
• Daily at 1pm, a computer-generated alert printed out a therapeutic antibiotic monitor report in ID department
• Utilized computer algorithms to screen for inconsistencies between antibiotics and microbiology test results
• In once year, 420 actionable alerts led to change or start therapy in 125 cases
• Physicians were previously unaware of relevant susceptibility test results in 49% of alerts

And Then (in the 2000’s) Came…

• An explosion of add on clinical decision support systems (CDSS) that run in parallel to Electronic Health Records (EHRs)

• Differentiators
  – Infection Prevention
  – Drugs covered
  – Reports
  – Customization
  – Portability
  – Timeliness to generate real time alerts
Assessment Question #1

How many commercial “add on” clinical decision support systems are currently available in the United States that have functionality for antibiotic stewardship?

A. 4  
B. 6  
C. 10  
D. 14
## “Add On” CDSS Vendors

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Company (also known as)</th>
<th>AU/AR Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>360 Care Insights</td>
<td>Truven Health Analytics</td>
<td>None</td>
</tr>
<tr>
<td>Bluebird</td>
<td>Intelligent Medical Systems</td>
<td>AU,AR</td>
</tr>
<tr>
<td>ICNet</td>
<td>Baxter Healthcare</td>
<td>AU</td>
</tr>
<tr>
<td>ILUM</td>
<td>ILUM Health Solutions (Merck HSS)</td>
<td>AU</td>
</tr>
<tr>
<td>IPAC</td>
<td>CKM Healthcare</td>
<td>Unknown</td>
</tr>
<tr>
<td>Medici</td>
<td>Asolva Inc</td>
<td>AU</td>
</tr>
<tr>
<td>Midas Health Analytics Solutions</td>
<td>Conduent Health</td>
<td>None</td>
</tr>
</tbody>
</table>

AU= Ability to report to CDC Antibiotic Use (AU) module in NHSN as of 10/1/17
AR= Ability to report to CDC Antibiotic Resistance module in NHSN as of 10/1/17
Source [http://www.sidp.org/aurvendors](http://www.sidp.org/aurvendors)
### “Add On” CDSS Vendors

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Company (also known as)</th>
<th>AU/AR Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Event Advisor</td>
<td>BD (Medmined)</td>
<td>AU</td>
</tr>
<tr>
<td>QC Pathfinder</td>
<td>Vecna Technologies</td>
<td>None</td>
</tr>
<tr>
<td>RL Solutions</td>
<td>RL Solutions</td>
<td>AU</td>
</tr>
<tr>
<td>Sentri 7</td>
<td>Wolters Kluwer (Pharmacy One Source)</td>
<td>AU</td>
</tr>
<tr>
<td>Teqqa</td>
<td>Teqqa</td>
<td>AU</td>
</tr>
<tr>
<td>Theradoc</td>
<td>Premier</td>
<td>AU,AR</td>
</tr>
<tr>
<td>VigiLanz</td>
<td>VigiLanz</td>
<td>AU,AR</td>
</tr>
</tbody>
</table>

**Source**
http://www.sidp.org/aurvendors

**Notes**
- AU = Ability to report to CDC Antibiotic Use (AU) module in NHSN as of 10/1/17
- AR = Ability to report to CDC Antibiotic Resistance module in NHSN as of 10/1/17
Categories of “Add on" Systems

1. Antibiotic Stewardship Only
2. Total Medication Stewardship
3. Total Medication Stewardship (including antibiotics) + Infection Prevention

Image source: https://phil.cdc.gov
VALUE OF AN “ADD ON” CDSS
Decreases Inappropriate Antibiotic Use

• 5 year quasi experimental, time interrupted series at a 677 bed academic medical center in Quebec.
• Utilized a CDSS + ASP team + prospective audit and feedback.
• N =35,778 pts reviewed.
  – Antibiotic defined daily dose/1000 patient days decreased by 32.4 (p<0.01)
  – Average length of stay decreased 0.92 days (p<0.01);
  – Spend decreased $19,649 (p=0.01)

Improves Clinical Workload Efficiency

- Academic Medical Center
  - 92 rule based alerts
  - 80 full time pharmacists + residents
  - 24/7 alerting
  - Total 399,979 alerts generated annually
  - 19% related to antibiotics
  - 17,333 documented interventions (4.3%) annually

Integrates with Rapid Diagnostics to Provide Real Time Actionable Results

- University of Michigan Health System study compared outcomes in 501 patients with bacteremia or candidemia
  - Pre-intervention group (n=256) and post intervention (n=245)
- Post intervention group combined MALDI TOF results with ASP intervention using add on CDSS
- Decreased time to organism identification (84.0 vs 55.9 hours, p<0.001)
- Improved time to effective antibiotic therapy (30.1 vs 20.4 hours, p=0.21)
- Additional benefits with mortality, length of ICU stay, and recurrent bacteremia

Huang AM, et al. Clinical Infectious Diseases 2013;57(9): 1237-45
Improves Quality of Care

• Disease state
  – Candidemia
  – HIV
  – Asymptomatic bacteriuria

• Core Measure compliance
  – Influenza vaccination
  – Sepsis
## Sepsis Bundle

The image above shows a dashboard for tracking sepsis bundle adherence rates. The dashboard includes data from May 2016 to May 2017, with monthly adherence rates for various sepsis measures.

### Sepsis Process

- **Measure**
  - 3hr All Bundle Measures Met
  - 3hr Blood Culture
  - 3hr Broad Spectrum Antibiotic
  - 3hr Fluid Bolus
  - 3hr Lactate Result

### Adherence Rates

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3hr All Bundle Measures Met</td>
<td>63%</td>
<td>61%</td>
<td>63%</td>
<td>60%</td>
<td>65%</td>
<td>63%</td>
<td>74%</td>
<td>84%</td>
<td>89%</td>
<td>94%</td>
<td>96%</td>
<td>96%</td>
<td>100%</td>
</tr>
<tr>
<td>3hr Blood Culture</td>
<td>70%</td>
<td>62%</td>
<td>63%</td>
<td>63%</td>
<td>67%</td>
<td>65%</td>
<td>75%</td>
<td>85%</td>
<td>91%</td>
<td>96%</td>
<td>96%</td>
<td>96%</td>
<td>100%</td>
</tr>
<tr>
<td>3hr Broad Spectrum Antibiotic</td>
<td>82%</td>
<td>88%</td>
<td>89%</td>
<td>93%</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
<td>95%</td>
<td>98%</td>
<td>96%</td>
<td>96%</td>
<td>96%</td>
<td>100%</td>
</tr>
<tr>
<td>3hr Fluid Bolus</td>
<td>60%</td>
<td>87%</td>
<td>93%</td>
<td>96%</td>
<td>93%</td>
<td>89%</td>
<td>97%</td>
<td>97%</td>
<td>99%</td>
<td>97%</td>
<td>95%</td>
<td>91%</td>
<td>100%</td>
</tr>
<tr>
<td>3hr Lactate Result</td>
<td>83%</td>
<td>80%</td>
<td>96%</td>
<td>95%</td>
<td>91%</td>
<td>90%</td>
<td>88%</td>
<td>95%</td>
<td>97%</td>
<td>96%</td>
<td>98%</td>
<td>96%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Notes

- The dashboard allows for filtering data by unit, week, quarter, age group, immunocompromised status, and related infection.
- The overall adherence rates range from 76% to 93%.

Image Source: Teqqa. Used with Permission
COMMONALITIES ACROSS SYSTEMS FOR ANTIBIOTIC STEWARDSHIP
## General Functionality

<table>
<thead>
<tr>
<th>Department</th>
<th>Areas of Interest/Focus</th>
</tr>
</thead>
</table>
| Infection prevention   | • NHSN tracking and reporting requirements  
                          • Identification of outbreaks/infection clusters  
                          • Ability to identify organisms with unusual resistance patterns |
| Microbiology           | • Antiobigram capabilities (CLSI compliant)                                              |
| Prescribers/ASP Team   | • Ability to suppress or triage alerts  
                          • Individual customization of alerts                                                      |
| Pharmacy               | • Basic ASP interventions  
                          • Intervention tracking  
                          • Target medication monitoring  
                          • Drug utilization reporting (e.g. Days of Therapy per 1000 pt days) |
## Basic Stewardship Interventions

<table>
<thead>
<tr>
<th>Basic Stewardship Interventions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bug- Drug Mismatch</td>
<td></td>
</tr>
<tr>
<td>Positive culture but no antibiotic</td>
<td></td>
</tr>
<tr>
<td>Receiving antibiotic but no positive culture</td>
<td></td>
</tr>
<tr>
<td>IV to PO</td>
<td></td>
</tr>
<tr>
<td>Antibiotic time out</td>
<td></td>
</tr>
<tr>
<td>Duration of therapy alerts</td>
<td></td>
</tr>
<tr>
<td>Duplicate antibiotic therapy</td>
<td></td>
</tr>
<tr>
<td>Dose adjustments due to renal or hepatic function</td>
<td></td>
</tr>
<tr>
<td>Therapeutic drug monitoring</td>
<td></td>
</tr>
<tr>
<td>Restricted drug monitoring</td>
<td></td>
</tr>
</tbody>
</table>
DIFFERENTIATORS FOR ANTIBIOTIC STEWARDSHIP
OR “THIS IS NOT YOUR MOTHER’S CLINICAL DECISION SUPPORT SYSTEM ANYMORE”
Unique features

• Interface with drug information systems
• Smart phone/tablet integration
• Key word searches
• Links to institutional guidelines
• Dose recommendations based on patient specific information
• Manages prior authorization
• Predictive analytics
Assessment Question #2

Which of the following is an example of how predictive analytics can be applied to antibiotic stewardship through a clinical decision support system?

A. Identification of patients in the early stages of sepsis
B. Review of previous culture(s) and susceptibilities to predict potential cause of a new infection in a patient
C. Assessing available patient parameters and cross referencing it to a population based database
D. All of the above
### Predictive Analytics

Image Source: TREAT SYSTEMS. Used with permission.
Intersection of Population and Personal Health

- Personalized Antibiotic Therapy
  - Therapy recommendations based on individual patient characteristics and population parameters

Image Source: Teqqa. Used with Permission
Outpatient Integration

Image Source: Teqqa. Used with Permission
Benchmarking

Tigecycline - National Comparison

<table>
<thead>
<tr>
<th></th>
<th>1Q 2015</th>
<th>2Q 2015</th>
<th>3Q 2015</th>
<th>4Q 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching (14)</td>
<td>1.9</td>
<td>1.8</td>
<td>1.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Non Teaching (90)</td>
<td>1.5</td>
<td>1.7</td>
<td>1.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Your Institution</td>
<td>12.9</td>
<td>16.5</td>
<td>2.4</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Image Source: BD MedMined. Used with permission
Comparison of utilization to resistance rates

Quinolone Utilization vs *C. difficile* Rate

<table>
<thead>
<tr>
<th>Quarter</th>
<th>DOT/1,000 DAR</th>
<th>C. difficile Marker Rate / 10,000 DAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3 2016</td>
<td>95</td>
<td>9.2</td>
</tr>
<tr>
<td>Q4 2016</td>
<td>88</td>
<td>7.1</td>
</tr>
<tr>
<td>Q1 2017</td>
<td>76</td>
<td>6.2</td>
</tr>
<tr>
<td>Q2 2017</td>
<td>84</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Quinolone Utilization vs *C. difficile* Rate

Measuring Economic Impact

Translate to cost, loss, and length of stay for hospital *C. difficile* cases

<table>
<thead>
<tr>
<th>NIM Set</th>
<th>Pts w NIM</th>
<th>Set Freq.</th>
<th>DRG-Adjusted Add’l Direct Cost</th>
<th>DRG-Adjusted Add’l Profit/(Loss)</th>
<th>DRG-Adjusted Add’l Length of Stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>stool(1)</td>
<td>55</td>
<td>12.11%</td>
<td>$3,500 $192,499</td>
<td>($3,093) ($170,089)</td>
<td>3.51 192.94</td>
</tr>
</tbody>
</table>

Image Source: BD MedMined. Used with permission
Reporting Capabilities

- User access
- Alert firing patterns
- Pre-populated dashboard
- Readmission tracking and reporting of rates
Key Takeaways

• Key Takeaway #1
  – Continually refine the add on CDSS after implementation to improve efficiency and eliminate alert fatigue

• Key Takeaway #2
  – Periodic data validation is important

• Key Takeaway #3
  – Monitor for unintended consequences

• Key Takeaway #4
  – Predictive functionality is becoming a strength of the add on CDSS and should be explored
How to use Electronic Health Records and Clinical Decision Support Systems Together for Antibiotic Stewardship

Whitney Buckel, Pharm.D., BCPS-AQ ID
System Antimicrobial Stewardship Pharmacist Manager
Intermountain Healthcare
Salt Lake City, UT
Learning Objectives

• List antimicrobial stewardship tools available in electronic health record (EHR) platforms.
• Review commonly used clinical decision support systems (CDSSs) and their role in enhancing antimicrobial stewardship.

• Describe how the EHR and CDSS can be used together as a successful antimicrobial stewardship tool.
Since 1975
- 23 hospitals
- 2,784 licensed beds

Since 1983
- Health plans
- 700,000+ members

Since 1994
- 1,200 employed physicians
- 558 advanced practice clinicians

Since 2015
- Centralized distribution center
<table>
<thead>
<tr>
<th>Facility</th>
<th>Bed Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bear River</td>
<td>16</td>
</tr>
<tr>
<td>Delta</td>
<td>18</td>
</tr>
<tr>
<td>Fillmore</td>
<td>19</td>
</tr>
<tr>
<td>Garfield</td>
<td>14</td>
</tr>
<tr>
<td>Heber</td>
<td>19</td>
</tr>
<tr>
<td>Sanpete</td>
<td>18</td>
</tr>
<tr>
<td>Cassia</td>
<td>25</td>
</tr>
<tr>
<td>Cedar City</td>
<td>48</td>
</tr>
<tr>
<td>Orem</td>
<td>24</td>
</tr>
<tr>
<td>Layton</td>
<td>43</td>
</tr>
<tr>
<td>Park City</td>
<td>30</td>
</tr>
<tr>
<td>Sevier</td>
<td>42</td>
</tr>
<tr>
<td>TOSH</td>
<td>40</td>
</tr>
<tr>
<td>Alta View</td>
<td>71</td>
</tr>
<tr>
<td>American Fork</td>
<td>89</td>
</tr>
<tr>
<td>Logan</td>
<td>146</td>
</tr>
<tr>
<td>Riverton</td>
<td>97</td>
</tr>
</tbody>
</table>

**Hospitals**

<table>
<thead>
<tr>
<th>Facility</th>
<th>Bed Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dixie</td>
<td>245</td>
</tr>
<tr>
<td>LDS Hospital</td>
<td>241</td>
</tr>
<tr>
<td>IMC</td>
<td>504</td>
</tr>
<tr>
<td>McKay Dee</td>
<td>305</td>
</tr>
<tr>
<td>Primary Children’s</td>
<td>289</td>
</tr>
<tr>
<td>Utah Valley</td>
<td>395</td>
</tr>
</tbody>
</table>
Maximizing Technology

- Empiric therapy
- Therapy modification
- Data tracking and reporting
- Research

All can be aided by add-on CDSS systems
Empiric Therapy

Objective:
• Reduce inappropriate variability in empiric antibiotic use

Strategies:
• Align antibiotic selection with local antibiogram in order sets
• Risk stratify who should receive broad-spectrum therapy
First-line (preferred) antibiotics are auto-checked. Alternative provided for patients with allergies.

Drop-down menu allows adjustment in dose.
Risk Stratification

DRIP score ≥ 4: Vancomycin, cefepime, plus azithromycin

Image Source: Intermountain Web Application. Used with permission.
## DRIP Implementation & Results

- ER physicians, inpatient hospitalists and pharmacists

<table>
<thead>
<tr>
<th>Observed Antibiotic Usage</th>
<th>DRIP n (%) (95% CI)</th>
<th>Usual Care n (%) (95% CI)</th>
<th>Difference, % points (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate Spectrum</td>
<td>6 (0.67) (0.31-1.5)</td>
<td>3 (0.93)</td>
<td>-0.25 (0.74 - -2.1)</td>
<td>NS</td>
</tr>
<tr>
<td>Any Broad Spectrum Antibiotic Use</td>
<td>199 (22.6) (19.7-25.1)</td>
<td>99 (30.6) (25.8-35.8)</td>
<td>-8.3 (-2.8 - -14.1)</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Practical Considerations

Strengths of add-on systems
• Provide data for developing order sets
• Facilitates complicated risk scores
• Relatively easy to extract data and update risk scores

Limitations of add-on systems
• Not easily integrated into workflow
• Dependent upon what data shared from EHR
• Needs to be tailored to the setting
Therapy Modification

Objective:
• Use the narrowest agent via the most optimal route for the shortest duration

Strategies:
• Intravenous (IV) to oral (PO) conversion alerts
• Bug-drug mismatch alerts for therapy escalation
• Finalized culture results alerts for de-escalation
• Duration of therapy alerts

Where add-on programs excel
Decision to Implement a Separate Clinical Decision Support System (CDSS)

We decided we needed a CDSS in order to:

• Prioritize who would benefit from infectious diseases review
• Expand prospective review to weekends and holidays
• More efficiently track and quantify interventions
Selection Criteria for our CDSS

After careful consideration, we chose our product based on:

• Clinically meaningful, consistently updated, rule based alerts
• Easy to use and thus easy to train all pharmacists to use it
• Integrated and useful reports
• Highly qualified and timely customer support
CDSS Implementation

After reviewing CDS systems and selecting best fit:

- Work with IT to send and validate data interfaces (months)
- ID pharmacist focused use and evaluation (2 weeks)
- Develop usage guidelines for pharmacists (6 - 8 weeks)
- Official roll out date for use by frontline pharmacists (2 weeks)

Education:
- Review pre-packaged alert options; determine team members
- Work with CDSS to solidify priority list of alerts; develop standardized reports
- Trouble-shooting; data feedback to frontline pharmacists

Ongoing:
- Education
- Addition, deletion, and refinement of alerts
- Data tracking and reporting
Different Practice Models

**Hospital A**
Two unit-based pharmacists evaluate and acknowledge all alerts

**Hospital B**
The ID pharmacist evaluates and acknowledges all alerts

**Hospital C**
All unit-based pharmacists evaluate one set of alerts; ID pharmacist evaluates another set
“High” versus “Medium” Alerts

High Alerts
- E.g. IV to PO, vancomycin concentrations

Medium Alerts
- E.g. restricted drugs, duration of therapy
- E.g. positive blood cultures
Example of Therapy Modification

Spectrum misses:
- Anaerobic cultures
- Bug-drug mismatches

Image Source: VigiLanz. Used with permission.
CDSS Education

• Provided educational documents
  – Basic Training Reference Guide
  – Clinical Guidelines and References for Alerts
• Each pharmacist received 1-on-1 hands-on training
• Each pharmacist completed a competency checklist
If there are any questions, please contact:
Whitney Buckel, PharmD, BCPS
Antimicrobial Stewardship Clinical Pharmacist
Intermountain Medical Center
Office: (801) 507-7784 (office)
Cell: (360) 609-0608 (cell)
Lync or Email at whitney.buckel@imail.org.

Why are we doing this? There is a national corn organism. As a part of this, there will be a national alert, which will be audited by CMS and future regulatory requirement. In addition, this responding to these alerts will facilitate improvement.

Contents
Getting Started
Daily Expectations
Leaving Notes for Other Pharmacists
Not Acknowledged Status
Follow Up Status
Acknowledging Activations
Rule Specific Information
Continuous Quality Improvement
Expectations for Infectious Diseases Pharmacist...
Questions and Answers

Below is a list of all activations that have been sent. These have been chosen based on patient safety. Following pages will give information about the activated on a patient.

Contents
*Staphylococcus aureus* positive blood culture.
*Staphylococcus aureus* positive urine culture.
*Clostridium difficile* on no treatment.
CSF culture positive — all updates.
Positive culture for *Pseudomonas, Acinetobacter*
Respiratory viral panel positive for influenza, *M*
Double anaerobic coverage with positive *Clc*
Bug-Drug Mismatch.
Blood culture positive.
*Streptococcus pneumoniae* or *Legionella* urine.
Vancomycin-resistant enterococci (VRE) not cur.
Gentamicin, Tobramycin, Amikacin, or Vancomycin.
Finalized culture from any site, other than blood.
IV to PO Conversion.
Extended Spectrum beta-lactamase (ESBL). Carl Carbapenem Resistant *Acinetobacter baumannii*
Gram negative anaerobic culture not on anaerobic.
CSF HSV / VZV Results.
Change in SCR increase or decrease by ≥0.5 or ≥
*Candida glabrata* or *Candida krusei* in blood and
On vancomycin and increase in SCR.

Employee Name:

<table>
<thead>
<tr>
<th>By the end of this training, I am able to:</th>
<th>Date</th>
<th>Method of Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successfully log in to Vigilanz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set up pharmacy surveillance home page</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Create a saved search</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set page preferences</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Understand the difference in the following activation statuses:
- Not Acknowledged
- Follow-up
- Acknowledged

Acknowledgment activations, specifically:
- Select appropriate status
- Select appropriate category
- Write an appropriate comment

Leave a message for another pharmacist:
- Other front-line pharmacists
- ID/Transplant pharmacist

Understand why it is important that I not acknowledge all alerts.
Access documents on TeamSpace.

I have reviewed the Rule List and Expectations.

I know the expectation is to acknowledge 95% of alerts for my unit within 24 hours.
I am committed to continuous quality improvement and will let ________ know if I have any cool ideas!

Method of Assessment

<table>
<thead>
<tr>
<th>O</th>
<th>Direct Observation</th>
<th>S</th>
<th>Skill Demonstration</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Verbal Response</td>
<td>T</td>
<td>Testing</td>
</tr>
</tbody>
</table>

Employee Signature: __________________________ Date: __________________________
Evaluator Signature: ________________________ Date: __________________________
CDSS Documentation

• Minimized entries: Acknowledge, Category and Comment
• Shortened list of categories
  – Originally: 17 options
    • E.g., “Renal function reviewed – recommended to provider – NOT accepted”
  – Now only 7 options
    • E.g., “Antimicrobial dose/route optimization”
• New comment feature: “Great Catch”
Practical Considerations

Strengths of add-on systems:
• Limited front-end building requirements
• Very easy to add customized alerts
• Easy documentation and data extraction

Limitations of add-on systems: 
Has to be used to be useful!
• Integration into the workflow
• Not just a technical challenge: also requires adaptive change
• Metrics and feedback of metrics to pharmacists is key
Tracking and Reporting

• Process Metrics – Focus for Today
  – Alerts and interventions
  – Antibiotic use rates

• Outcomes Metrics
  – Antibiotic resistance and *Clostridium difficile* rates
Track and Report: Interventions

% Alerts Acknowledged at Facilities A-H

- Week 1
- Week 2
- Week 3
- Week 4
- Week 5
- Week 6

Facilities:
- A
- B
- C
- D
- E
- F
- G
- H
Track and Report: Great Catches

- “Great Catch. Pharmacist notified physician to change therapy based on culture and sensitivity review. Patient was sent home on Augmentin. *E. coli* came back resistant. Notified surgery PA of culture results and she was going to follow up with patient's surgeon to change antibiotics.”
  - Joylyn Call, PharmD

- “Physician was not aware 2/2 sets positive for *S. aureus* and mBAL too. Physician thought it was 1/2 bottles contaminant. Informed by pharmacist, vancomycin started. Great catch.”
  - Stephanie Chauv, PharmD

- "Great Catch. Pharmacist notified physician to change therapy based on culture and sensitivity review. Patient was sent home on Augmentin. *E. coli* came back resistant. Notified surgery PA of culture results and she was going to follow up with patient's surgeon to change antibiotics.”

- "Physician was not aware 2/2 sets positive for *S. aureus* and mBAL too. Physician thought it was 1/2 bottles contaminant. Informed by pharmacist, vancomycin started. Great catch.”

- - Stephanie Chauv, PharmD
Track and Report: Antibiotic Use

- Overall antibiotic use at a high-level
  - NHSN AUR option reporting to the CDC
    - Numerator: days of therapy (eMAR)
    - Denominator: patient days present
  - CDSS systems and EHRs can work together to process antibiotic use data

Track and Report: Antibiotic Use

• Specific antibiotic use or antibiotic use in specific areas
  – Review and identify variation and trends
  – Significant trends can become a targeted project
    • E.g., clindamycin usage after new EMR implementation by
      Laurie Blankenship, PharmD; Park City Hospital Pharmacy Director
**Percentage Appropriate Doses - Clindamycin**

- **Start of Data Analysis**: 2015-07
- **iCentra Implementation**: 2015-08
- **Pharmacy Reject Until Justified**: 2015-09
- **Nursing Allergy Education**: 2015-10
- **Surgeon Education**: 2015-11
- **Med Safety**: 2015-12
- **Algorithm Implementation**: 2016-01
- **Algorithm Implementation**: 2016-02
- **Algorithm Implementation**: 2016-03
- **Algorithm Implementation**: 2016-04
- **Algorithm Implementation**: 2016-05
- **Algorithm Implementation**: 2016-06
- **Algorithm Implementation**: 2016-07
- **Algorithm Implementation**: 2016-08
- **Algorithm Implementation**: 2016-09
- **Algorithm Implementation**: 2016-10
- **Algorithm Implementation**: 2016-11
- **Algorithm Implementation**: 2016-12
- **Algorithm Implementation**: 2017-01
- **Algorithm Implementation**: 2017-02
Research

• Retrospective studies
  – Reviewing active alerts and interventions
  – Utilize auto-verify alerts

• Prospective studies
  – Patient identification for enrollment in trials
  – Real-time stewardship interventions
Self-Assessment Question

When implementing an add-on stewardship program, which of the following is most important:

A. A detailed documentation process
B. Utilization of both Infectious Diseases and front-line pharmacists
C. Having a training assessment tool
D. Tracking and feeding back data on alerts and interventions
Key Takeaways: When to Synergize CDSS with or within your EHR

- To implement complicated empiric therapy recommendations
  - Example: Scoring methods for assessing risk for drug resistance, data to develop HER order sets, and empiric-therapy based alerts
- To identify needed therapy modifications
  - Example: Smart alerts to trigger pharmacist evaluation (IV to PO), bug-drug mismatch alerts, and/or rapid diagnostic test results
- To track and report results
  - Example: Alert acknowledgement, intervention, and/or antibiotic use rates
Acknowledgements

• Laurie Blankenship, PharmD
• Lindsay Butterfield, PharmD and the Pharmacy Informatics Team
• Richard Ensign, PharmD and the Pharmacy Analyst Team
• Peter Jones, MS, Valoere Stanfield, MS, and Eddie Stenehjem, MD and the System Antimicrobial Stewardship Team
• Brandon Webb, MD and Nat Dean, MD and Pneumonia Workgroup
• David Skarda, MD and Surgery Clinical Program
Leveraging Technology and Informatics for Antimicrobial Stewardship: Questions?

Edina Avdic, Pharm.D, M.B.A., BCPS-AQ ID
Kristi Kuper, Pharm.D., BCPS
Whitney Buckel, Pharm.D., BCPS-AQ ID