Incorporating Automation and Rapid Diagnostic Technologies into the Micro Lab's Lean Workflow to Boost Productivity, Shorten Length of Stay, and Improve Antibiotic Utilization

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Appalachian Regional Healthcare System

- Located in mountains of northwest North Carolina
- Watauga Medical Center – 117 bed regional medical complex
- Cannon Memorial Hospital – 25 bed critical access hospital with 10 bed inpatient behavioral health unit
- Foley Center at Chestnut Ridge – 112 bed post-acute care facility
- ARMA – 12 practice multi-specialty medical practice management corporation

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ARHS Clinical Laboratories

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- Watauga Medical Center (WMC)
  - 26.4 worked FTEs
  - Full service Blood Bank
  - Microbiology for entire region
- Cannon Memorial Hospital (CMH)
  - 7.7 worked FTEs
  - Minimal blood bank
  - Courier to WMC 4x per day
- Leadership
  - Steven Bredehoeft – System Laboratory Medical Director
  - Wendy Williams – System Laboratory Administrative Director
  - Shannon Stacy – System Regulatory Supervisor
  - Cannon – daily on-site supervisor
  - WMC – Section Supervisors in Hematology, Blood Bank, Microbiology, Chemistry, Point of Care + daily shift supervisors

Lean in the ARHS Laboratories

- 2007 – ER Turnaround Time A3 at Cannon
- 2009 – 5s WMC Lab
- 2010 – A3 for WMC Pre-Analytic Workflow
- 2010 – A3 for Outpatient Imaging Center Workflow
- 2013 – WMC Lab Redesign
- 2014 – WMC Lab Turnaround Time A3
- 2015 – Microbiology Analytics Platform changes
- 2016 – Outpatient Imaging Admissions Workflow A3

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2010 – A3 for WMC Pre-Analytic Workflow

- Collaboration between ARMA office staff, courier and lab
- Redesigned office workflow to fax orders to admissions for registration at time of collection – reduced waiting time for samples once arrive in lab
- Redesigned courier route to maximize efficiency
- Redesigned lab workflow to improve turnaround time once samples received – assigned staffing specifically to work on incoming courier samples

*Still have improvement opportunities with office workflow

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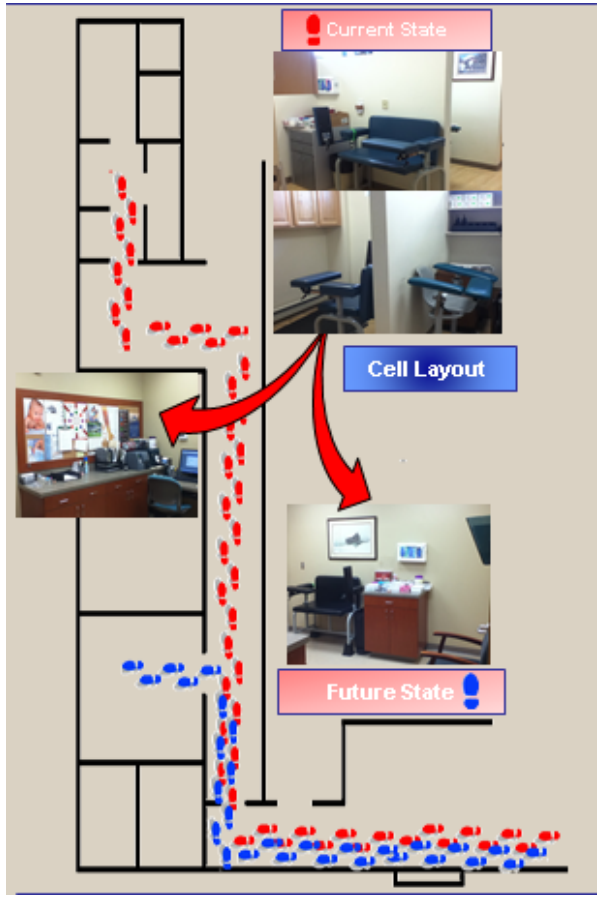
A3 for Outpatient Imaging Center Workflow

- Moved lab drawn room location within in building
- Saw a 74.5% improvement in patient steps taken
- Saw 87.2% improvement in staff steps taken



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2014 – WMC Lab Turnaround Time A3

- Rapid serum tubes (5 min clot time) used to standardize collections and reduce sample wait time
- Discontinued process of routinely repeating panics
- Implemented partial autoposting of CBCs (already had urinalysis and coagulation studies autoposting)
- Order Status Boards in Lab (real time pending lists)
- Individual Performance Reports

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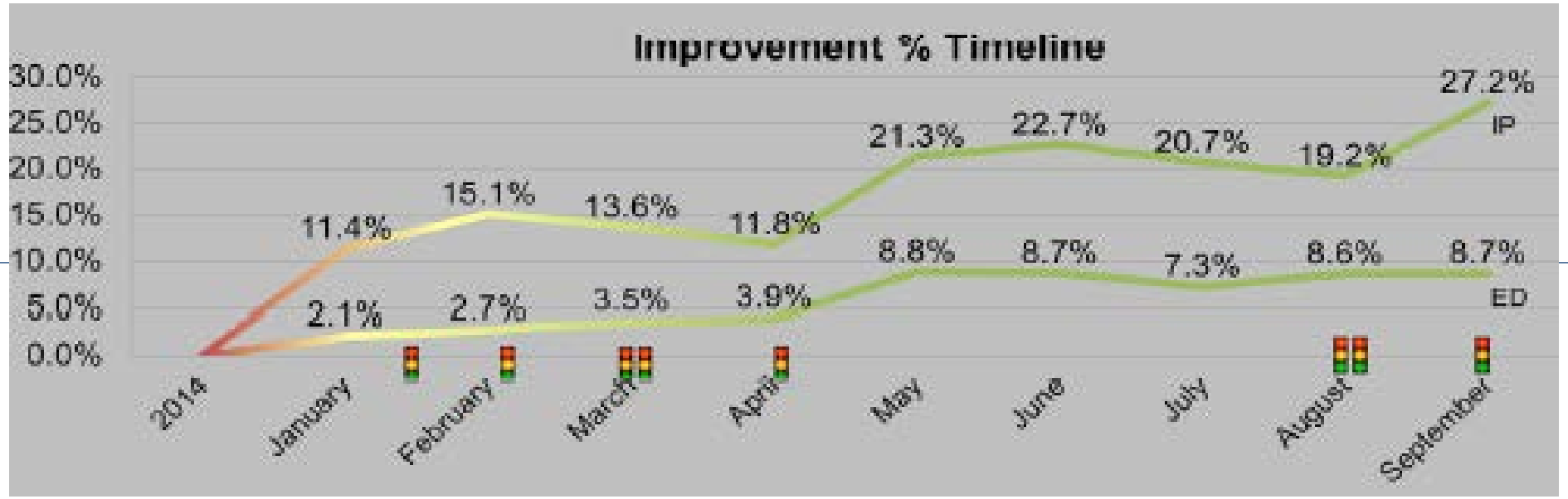
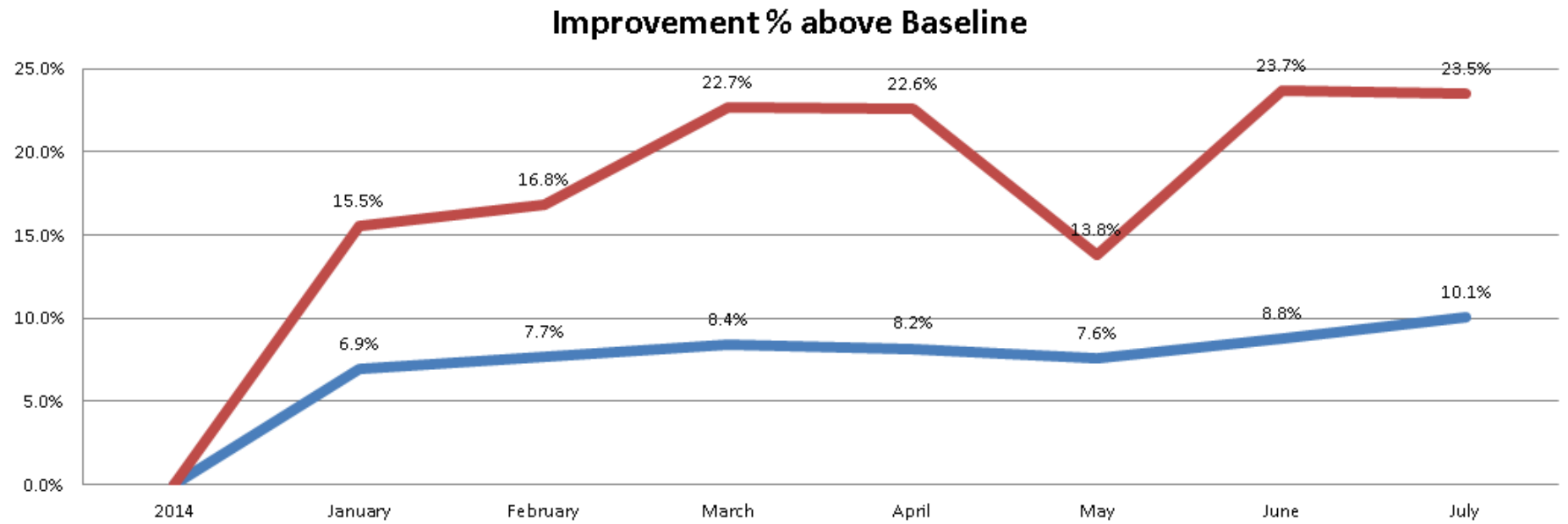
2015 data



2017 data



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Microbiology Analytics Platform changes

- 2 stage implementation process
  - 2015 – Moved to Mass Spec for rapid identification and Vitek 2 for antibiotic sensitivity testing
  - 2016 – Added Biofire for rapid molecular diagnostics

Revolutionized Microbiology workflow

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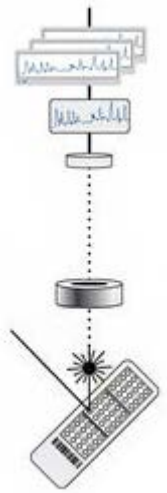
Vitek Mass Spec

- Vitek MS - automated mass spectrometry microbial identification system that uses Matrix Assisted Laser Desorption Ionization Time-of-Flight (**MALDI-TOF**) technology

HOW MALDI-TOF works

1. The target slide is prepared and introduced to a high-vacuum environment.
2. A precise laser burst ionizes the sample.
3. A "cloud" of proteins is released and accelerated by an electric charge.
4. After passing through the ring electrode, the proteins' Time of Flight is recorded using a formula from the time recorded.
5. Proteins are detected with a sensor to create a spectrum that represents the protein makeup of each sample.



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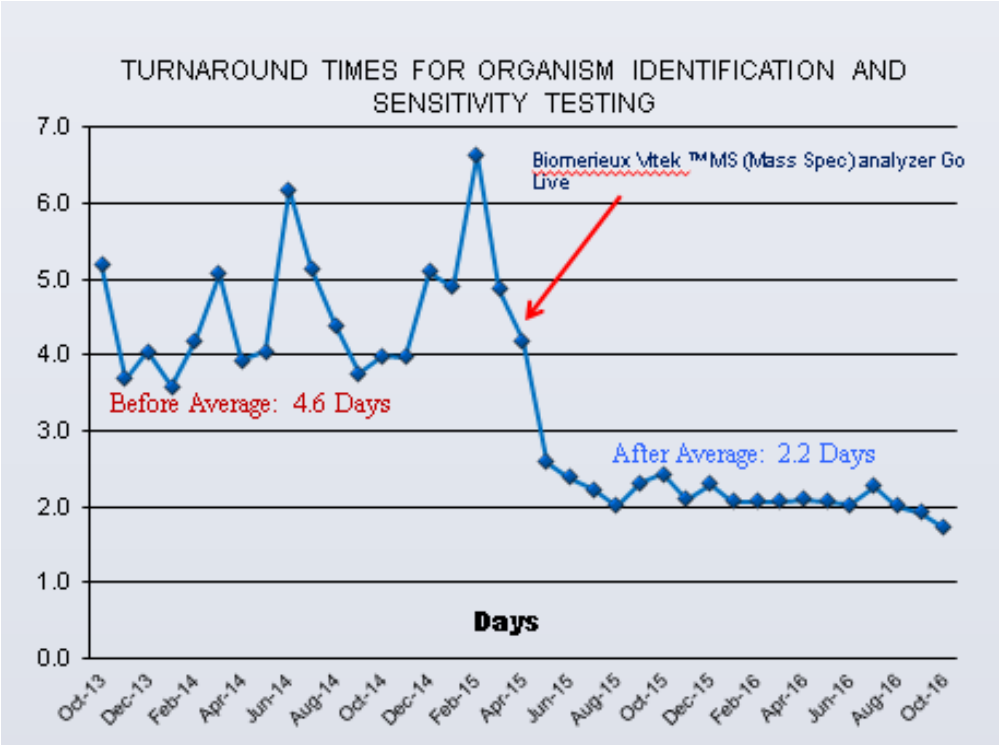
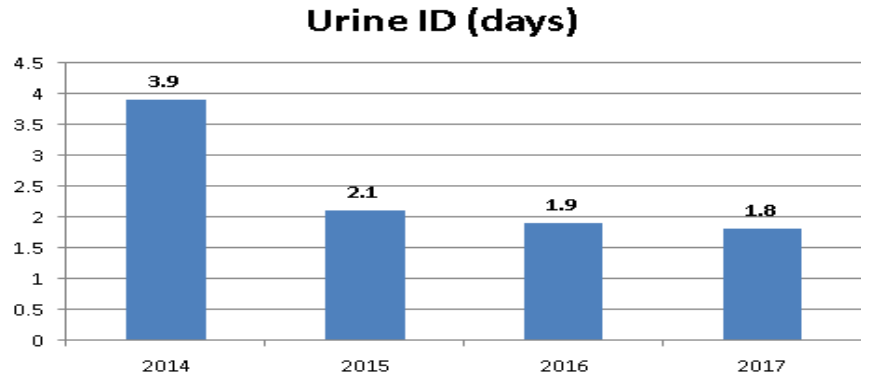
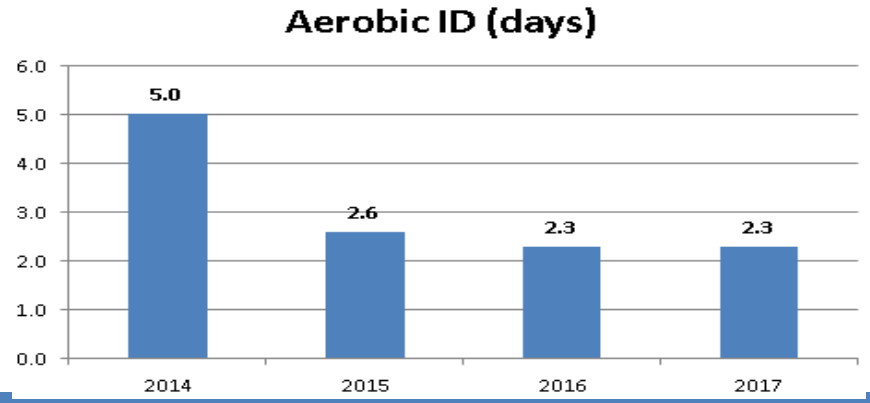
Culture ID and Sensitivity Testing

- 67% decrease in standard testing time
- Only optimization made during implementation was how we stored/sorted culture plates







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Biofire Rapid Molecular Diagnostic Testing

- Multiplex PCR panels on 2 instruments (Torch and Film Array 2.0)
- Respiratory Panel – 20 targets (viral and bacterial) *
- Respiratory Panel 2 – 21 targets (viral and bacterial)
- Respiratory Panel EZ – 14 targets (CLIA Waived)
- GI Panel – 22 targets (bacterial, viral and parasites)*
- Meningitis Panel – 14 targets (bacterial, viral, yeast)*
- Blood Culture Panel – 27 targets (Bacterial, Fungal, antibiotic resistance genes)

*used at ARHS

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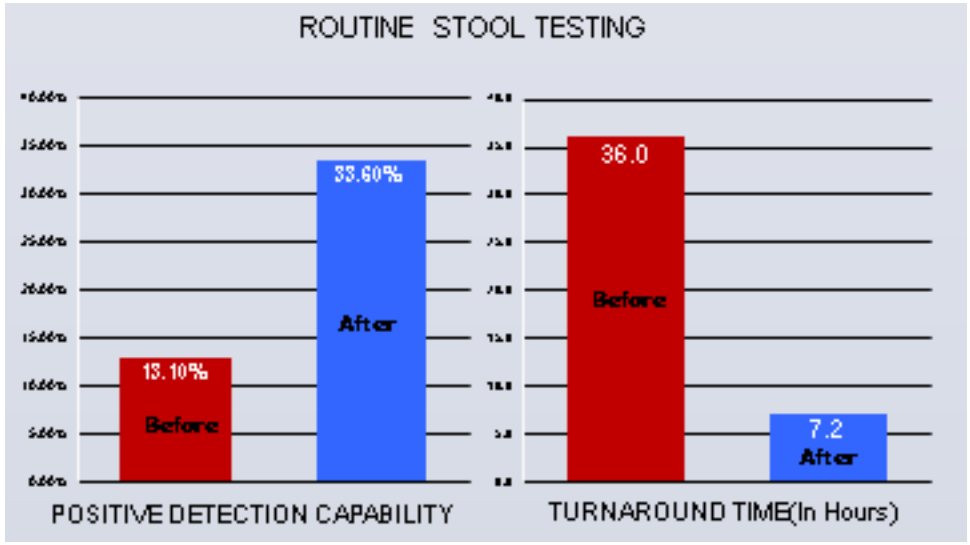
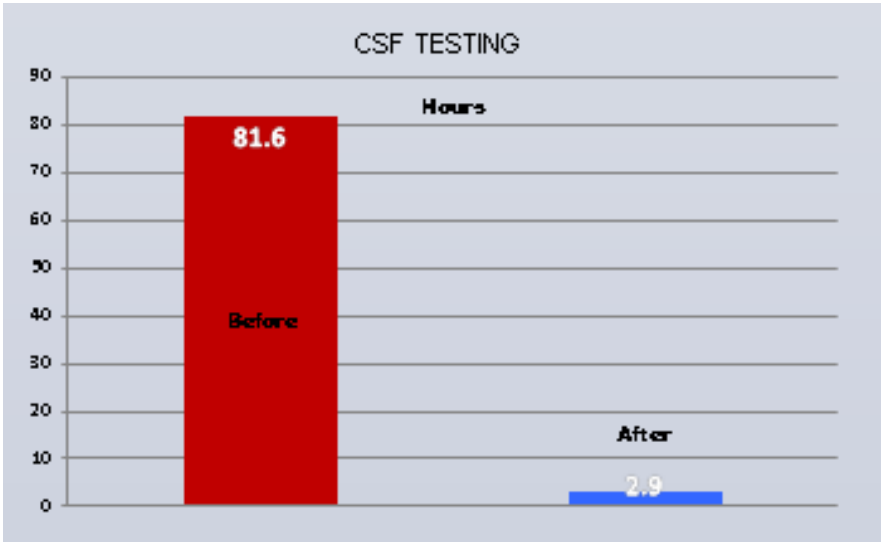
Rapid Molecular Testing

- Turnaround time improvements for critical CSF testing from 3.4 days from collection for routine CSF culture to 2.9 hours from collection for the PCR panel.
- Improvement in the positive detection capability for routine stool testing from 13.1% to 33.6% with a turnaround time improvement from 1.5 days to 7.2 hours from collection
- GI Panel has current ED TAT average of 2.3 hours





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Impact on Patient Care

- Length of stay for patients admitted with positive cultures has dropped by 6.3%.
- Length of stay has dropped from 4.8 days to 3.2 days for patients admitted with CSF testing being performed during their stay with a minimum savings of $1400 per stay

$121,000 annual savings to patients

- Length of stay for patients with stool testing being performed has dropped from 5.0 days to 3.9 days with a minimum savings of $960 per stay

$87,000 annual savings to patients

- Saw a 5% decrease in admissions for patients having the multiplex PCR testing performed as compared to admission rates with traditional testing methods.

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Cost versus Technology/Improvement

- Mass Spec – costs pennies per ID; cost is in instrumentation
- GI Panel – costs 8-10+ times as much as traditional stool culture testing method; cost effective if able to reduce stand alone stool testing in addition to culture (ex. O &P, C. diff)
- Respiratory Panel – multiplex panel more expensive than individual testing
- Benefit of all is speed and diagnosis over cost

Antibiotic Stewardship

- The quick initiation of antibiotics to treat infections has been proven to save lives; however, the CDC estimates 20%-50% of all antibiotics prescribed in U.S. acute-care hospitals are either unnecessary or inappropriate.
- Antibiotics can have serious side effects, including adverse drug reactions and Clostridium difficile infection. Unnecessarily prescribed antibiotics place patients at-risk for serious adverse events and provide patients with no clinical benefit. The misuse of antibiotics has also contributed to an increase in antibiotic resistance, which has become one of the most serious threats in public health. The CDC estimates more than two million people are infected with antibiotic-resistant organisms, leading to approximately 23,000 deaths annually.
- Antimicrobial stewardship can help prevent the development of multidrug resistant organisms, and reduce unnecessary drug use and costs associated with expensive, broad-spectrum therapies used to treat HAIs. (Joint Commission, 2017)
- Antimicrobial stewardship is based on the "three Ds", the right drug, the right dose and the right duration.

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Antibiotic Stewardship – CDC Core Program Elements

- **Leadership Commitment:** Dedicating necessary human, financial and information technology resources
- **Accountability:** Appointing a single leader responsible for program outcomes. Experience with successful programs show that a physician leader is effective
- **Drug Expertise:** Appointing a single pharmacist leader responsible for working to improve antibiotic use.
- **Action:** Implementing at least one recommended action, such as systemic evaluation of ongoing treatment need after a set period of initial treatment (i.e. “antibiotic time out” after 48 hours)
- **Tracking:** Monitoring antibiotic prescribing and resistance patterns
- **Reporting:** Regular reporting information on antibiotic use and resistance to doctors, nurses and relevant staff
- **Education:** Educating clinicians about resistance and optimal prescribing

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Antibiotic Stewardship - ARHS

- ARHS Outpatients:
  - Providers do not routinely prescribe prophylactic antibiotics for UTIs prior to receiving ID/Sensitivity
- ARHS ED Patients:
  - GI Panels performed and resulted before release from ED in patients with diarrhea
  - Providers do not routinely prescribe prophylactic antibiotics for UTIs prior to receiving ID/Sensitivity
- ARHS Inpatients:
  - Use Theradoc to organize stewardship activities
  - Pulls data from Allscripts (lab results, antibiotics, diagnoses, allergies, etc…)
  - Rapid reporting via email to Pharmacy for: positive cultures, bug-drug mismatches, MDROs, patients on antibiotics >72 hours, etc…
  - Pharmacy works directly with provider to modify antibiotics and discontinue unnecessary antibiotics (24/7 coverage)
  - Pharmacy works directly with Lab to ensure antibiotics being tested and reported for susceptibility testing matches formulary
  - Subcommittee of P&T Committee; meets quarterly

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2018 ARHS Leadership Infection Control Goals

- No hospital-acquired C. difficile infections
- No Catheter Associated Urinary Tract Infections (CAUTI)
- No Central Line Associated Blood Stream Infections (CLABSI)

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Lessons Learned

- Keep up with technology coming to market and on horizon
- Need buy-in from providers to move to multiplex panels with understanding of increased cost to patient versus benefit of diagnosis to patient
- Lab testing cost is more expensive and that expense is passed on to patients – work with Finance to ensure that the cost isn't too extreme – patients don't always see bigger picture
- Need hand-in-hand work with Pharmacy in deciding on, building and implementing susceptibility testing to meet formulary and prescribing patterns

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