



# Antimicrobial Stewardship: Longitudinal Outcomes of Performance Improvement

## St. Luke's University Health Network

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### ***Executive Summary***

The CDC estimates that approximately 20-50% of all antibiotic use in the United States is either inappropriate or all-together unnecessary. This inappropriate antibiotic use can lead to various antibiotic-associated collateral damage, including adverse drug events (e.g., side effects, allergic reactions, drug interactions), superinfections (e.g., C. diff, yeast, other opportunistic pathogens), and the development of multi-drug resistant organisms. Reports estimate that if antimicrobial resistance is not addressed, it is predicted that by 2050, antimicrobial resistance will result in 10 million deaths annually, costing over \$100 trillion in economic output. In 2016, The Joint Commission established a requirement that all health-systems establish an antimicrobial stewardship program to help combat antimicrobial resistance and improve patient outcomes.

The creation of a comprehensive AMS program is a large undertaking and it is not something that can be done in a vacuum. Support and education of the hospital community is crucial to making meaningful and sustained changes to antimicrobial usage. Many playbooks and frameworks exist for the development of a program. These are not one size fits all and first

it needed to be decided what approach would be best for St. Luke's University Health Network.

The establishment of a charter and overarching principles was key. Additional background infrastructure to support the educational elements including a MyNet page were established. The AMS program is a blend of prospective review, Infectious Disease Provider and Infectious Disease Pharmacist collaboration, and guidelines to achieve more appropriate anti-infective utilization. It was felt by the team that this structure would best align with the collaborative educationally based culture of SLUHN and would be more sustainable than a program of significant medication access restriction or prospective drug use approval. Once the structure was determined, a more focused approach to the decreasing of inappropriate antibiotic prescribing needed to be determined. Little in the way of complete background data was available, but existing data from a previous project was reviewed.

The data was Bethlehem based and not representative of the network hospitals fully but provided a starting point for focused interventions. Additionally, data metrics were established to track progress. Due to the large scope of the project, it was anticipated that it would take time to see impact of interventions including treatment guidelines and that an individual action may not demonstrate a change in utilization significant enough to have a substantial change in the data. Also built into the baseline framework for the program was the development of an annual action plan by campus utilizing campus specific data to drive specific interventions per site.

Many metrics are utilized to track the success and progress of the AMS program. One of the most useful metrics is days of therapy per 1,000 patient days (DOT). This is the number of days that a patient receives a particular antimicrobial agent, normalized to allow comparison between hospitals of different sizes. This metric is useful to trend over months to years to help identify situations when broad-spectrum antibiotics are being over-utilized. For example, an increase in aztreonam DOT at the St. Luke's Miners campus from year to year would indicate potential overuse, allowing the AMS team to target individuals at the Miners campus for education on appropriate aztreonam use.

Therefore, decreases in DOT for broad-spectrum antimicrobials over time would be considered a success for the AMS program. Another metric that was added is daily interventions made by the ID pharmacist(s) and physicians during daily prospective chart review. The pharmacist and physicians document the actions taken related to specific patients indicating what was recommended as well as the acceptance of the recommendation. Interventions are tracked on a yearly basis, and additional information is tracked on intervention type, acceptance rate, and cost-savings associated with each intervention. Rates of Clostridium difficile infection (CDI), which often occurs as a direct result of broad-spectrum antibiotic overutilization, are also tracked. This metric is also a reflection of collaborative efforts with the infection preventionist staff.

Since the formal advent of the AMS program at St. Luke's, we have decreased broad

spectrum antibiotic utilization by almost 22%. FY20 was the first year that interventions made by the AMS program were formally logged and analyzed. Since that time, the AMS program intervened on nearly 6,000 patients, with an intervention success rate near 90%. The interventions made by the AMS program have resulted in a cumulative cost-savings of over \$768,000, with potential for another \$102,000+ in savings from recommendations for interventions that were not accepted by the provider. In addition, the CDI SIR has been reduced by over 48% since FY18.

### ***The Clinical Problem and Pre-Implementation Performance***

Prior to the development of the antimicrobial stewardship program, there was no performance data to compare or use as a standard of care. Our program was the first of its kind for our network.

- Example: CAUTI Bundle Utilization, Diabetic HgbA1C Poor Control, Time to Needle for Stroke Patients
- Days of therapy per 1,000 patient days (DOT) – the number of days that a patient receives a particular antimicrobial agent, normalized to allow comparison between hospitals of different size
- Interventions – any recommendation made to a provider during prospective chart review that impacts a patient’s antimicrobial regimen
- Actual cost-savings – the total cost of antibiotics saved for recommendations accepted during prospective chart review
- Potential cost-savings – the total cost of antibiotics saved for recommendations that were not accepted during prospective chart review
- CDI rates – occurrence of *Clostridioides difficile* infections
- CDI SIR – *C. difficile* infection standardized infection ratio – network CDI rates standardized to the expected CDI rate based on regional trends

The steward organization that owns a measure and is responsible for maintaining the measure is the Center for Disease Control (CDC) and Infectious Diseases Society of America (IDSA). The targeted performance goal for improved adherence to the standard of care is an annual 5% decrease in broad-spectrum antibiotic utilization.

### ***Design and Implementation Model Practices and Governance***

The AMS program is a blend of prospective review, Infectious Disease Provider and Infectious Disease Pharmacist collaboration, and guideline development to achieve more appropriate anti-infective utilization. It was felt by the team that this structure would best align with the collaborative educationally based culture of SLUHN and would be more sustainable than a program of significant medication access restriction or prospective drug use approval.

### ***Workflow design and solution selection, testing, and field testing process***

- The AMS program utilizes various methods to improve antibiotic utilization and thereby optimize patient outcomes. These include direct prospective chart review, development of treatment guidelines and order sets, education.

- In order to develop a successful AMS program, buy-in is necessary from providers and hospital leadership. In addition, constant collaboration is required with other vital stakeholders, including infection prevention, microbiology, pharmacy leadership, and many others.

### ***Tools, Resources, and Timeline***

- Timeline: longitudinal
- Tools and Resources
  - Presentations at practice/section meetings
  - Email reminders / updates to providers
  - Medical Grand Rounds presentations
  - Electronic educations (my-eLearning)
  - Order sets for treatment indications
  - Communication through infectious diseases website (on intranet)

### ***Clinical Transformation enabled through Information and Technology***

This section is devoted to describing the longitudinal clinical workflow and all the different touchpoints where information and technology drives improved adherence to the standard of care. This section should include:

### ***AI Utilizing clinical data***

- Stewardship/infection prevention module in Epic called Buggy forages for patients meeting a variety of clinical scenarios which warrant actionable antibiotic interventions.
  - De-escalation opportunities
  - Drug-drug mismatches
  - Drug-Lab Mismatch
  - Antibiotics with potential IV to PO conversion
  - Duplicate Coverage
  - Bug-Drug: Positive blood culture and broad-spectrum antimicrobial
  - Restricted and High-Risk Antimicrobials
  - Duplicate Antipseudomonal Coverage
- Stewardship lists built into Epic which automatically forage for patients who meet certain criteria developed based on identified areas for improvement
  - Med-surg patients receiving vancomycin, cefepime, and/or zosyn
    - Network and individual campus lists built
- 72-hour antibiotic “timeout” built into Epic that prompts providers to re- evaluate patients receiving broad-spectrum antibiotics for at least 72 hours

Decision support has been built into the EMR for various infectious treatment indications, these guidelines include, pneumonia (see below), CNS infection, skin and soft tissue infections, urinary tract infections, among others.

**Order Sets**

▶ Labs

- Procalcitonin (with reflex)
  - Procalcitonin (\$\$\$\$\$)
    - ↳ Add to specimen collected 5h ago?
      - Once, today at 1422, For 1 occurrence
      - New collection
      - Blood
  - Procalcitonin, Next Day AM Collection (\$\$\$\$\$)
    - Morning draw, tomorrow at 0600, For 1 occurrence
    - Blood

▶ Imaging

▶ Other Tests

▶ IV Fluids

▶ Medications

▼ CAP: Determine Severity and MDRO Risk to Guide Antibiotic Therapy

Severe CAP Classification	
Meet either ONE (1) MAJOR or THREE (3) MINOR criteria	
Major Criteria	Septic shock with need for vasopressors
	Respiratory failure requiring mechanical ventilation
Minor Criteria	Respiratory rate $\geq 30$
	PaO <sub>2</sub> /FIO <sub>2</sub> ratio $\leq 250$
	Multilobar infiltrates
	Confusion/disorientation
	BUN $\geq 20$
	WBC $< 4,000$ due to infection
	Platelets $< 100,000$
Hypothermia $< 96.8^{\circ}\text{F}$	
	Hypotension requiring aggressive fluid resuscitation

DRIP Score Calculation	
Characteristic	Points
<b>Major Risk Factors</b>	
Antibiotic use within prior 60 days	2
Residence in a long-term-care facility (NOT assisted living facility)	2
Enteral tube feeding	2
Infection with a resistant pathogen (e.g., MRSA, Pseudomonas, ESBL) within 1 year	2
<b>Minor Risk Factors</b>	
Inpatient hospitalization within prior 60 days	1
Chronic lung disease (COPD or structural)	1
Poor functional status (non-ambulatory or Kamofsky $< 70$ )	1
Gastric acid suppression	1
Wound care	1
MRSA colonization within prior 1 year	1
<b>Total Points Possible</b>	<b>14</b>

**Order Sets**

Severe CAP is defined by meeting **one** major or **three** minor criteria as outlined in table above  
**High-risk** of MDR pathogens is defined by **DRIP score  $\geq 4$**

4 Categories of community-acquired pneumonia:

- Non-severe with **low**-risk of MDR pathogens
- Non-severe with **high**-risk of MDR pathogens
- Severe with **low**-risk of MDR pathogens
- Severe with **high**-risk of MDR pathogens

Note: Anaerobic coverage **no longer needed for the treatment** of aspiration pneumonia.

▼ Non-severe CAP & Any Drip Score

▼ First-Line Therapy

- ceftRIAXone (ROCEPHIN) IV (\$\$)  
1,000 mg, Intravenous, Every 24 hours

▼ Cefuroxime, 3rd, or 4th Generation Cephalosporin Allergy

- ampicillin-sulbactam (UNASYN) IV (\$\$\$)  
3 g, Intravenous, Every 6 hours

▼ Penicillin, Cefuroxime, 3rd, or 4th Generation Cephalosporin Allergy

- levofloxacin (LEVAQUIN) tablet (\$)  
750 mg, Oral, Every 24 hours
- levofloxacin (LEVAQUIN) IV (\$\$)  
750 mg, Intravenous, Every 24 hours

▼ Empyema, Cavitory Pneumonia, or Lung Abscess

- Ceftriaxone IV + Metronidazole PO
- Ceftriaxone IV + Metronidazole IV
- ampicillin-sulbactam (UNASYN) IV (\$\$\$)  
3 g, Intravenous, Every 6 hours

▼ Add-on Azithromycin or Doxycycline if Patchy Infiltrates or Concern for Legionella (NOT needed if prescribing levofloxacin)

- azithromycin (ZITHROMAX) tablet (\$\$)  
500 mg, Oral, Every 24 hours
- azithromycin (ZITHROMAX) IV (\$\$)  
500 mg, Intravenous, Every 24 hours
- doxycycline hyclate (VIBRAMYCIN) capsule (\$)  
100 mg, Oral, Every 12 hours
- doxycycline (VIBRAMYCIN) IV (\$\$\$)  
100 mg, Intravenous, Every 12 hours

▼ Severe CAP & low risk of MDRO (Drip Score less than 4)

- ▶ First-Line Therapy Click for more
- ▶ Therapy Substitution for Macrolide Allergy or QTc Prolongation Click for more

Internal treatment guidelines are developed and reviewed and revised continuously as new clinical literature becomes available or new consensus guidelines are developed by important infectious diseases societies/organizations such as IDSA, CDC, WHO, etc.

### ***Tools and Resources***

The AMS program collaborates at least monthly with the infection prevention group. AMS reports out monthly at infection preventionist site-specific meetings, and quarterly at the network specific meeting, on upcoming projects and initiatives in stewardship. AMS collaborates with the infection preventionists by reviewing all hospital-acquired infection (including CDIs) and surgical site infection patients for opportunities for antibiotic optimization.

### ***Improving Adherence to the Standard of Care***

Our primary goal was to achieve at least a 5% decrease annually in broad- spectrum antibiotic utilization. CMS has yet to establish a standardized benchmark for broad-spectrum antibiotic reduction

Data is collected utilizing various sources. These include reports from EPIC, network financial statements (patient days), and antibiotic utilization reports by FY/quarter from BI. The data extracted into spreadsheets for review and analysis.

### ***Improving Patient Outcomes***

- Lowered Mortality for the specific disease state/acute clinical problem highlighted in the case study
- Reduced length of stay for patients meeting the denominator for the process/adherence to the standard of care measure described in the previous section.
- Reduced readmissions within 30 days for patients meeting the denominator for the process/adherence to the standard of care measure described in the previous section.
- Improved morbidity and disease management associated with patients meeting the denominator definition described in the previous section. This can include:
  - Chronic disease control (HmgbA1C or High Blood Pressure control)
  - Reductions in adverse events, hospital acquired conditions, and hospital acquired infections

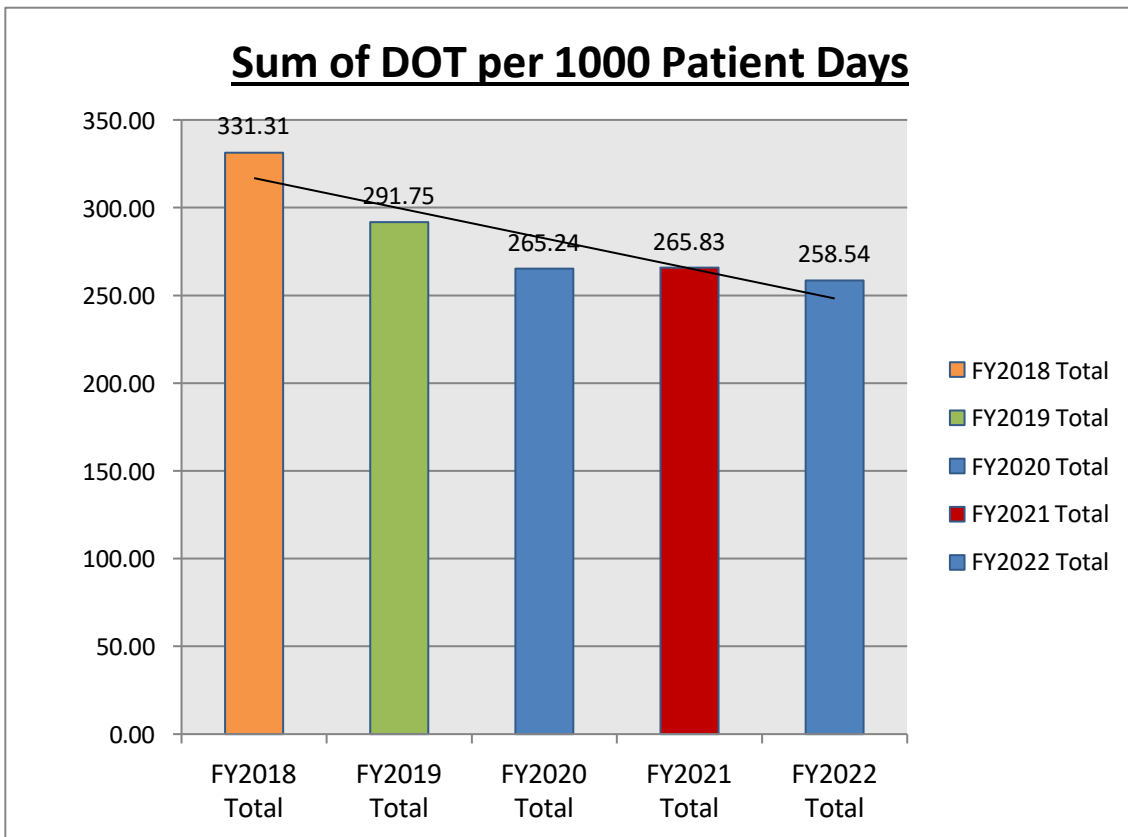
### ***Benefits to Public Health***

- Chronic disease control (HmgbA1C or High Blood Pressure control)
- Reductions in adverse events, hospital acquired conditions, and hospital acquired infections,
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## Network Broad Spectrum Antibiotic DOTs Over Time

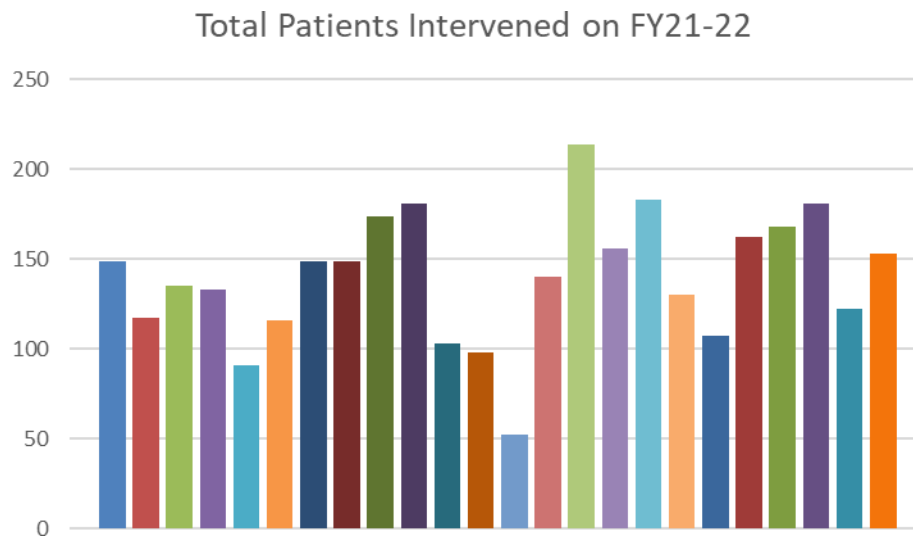


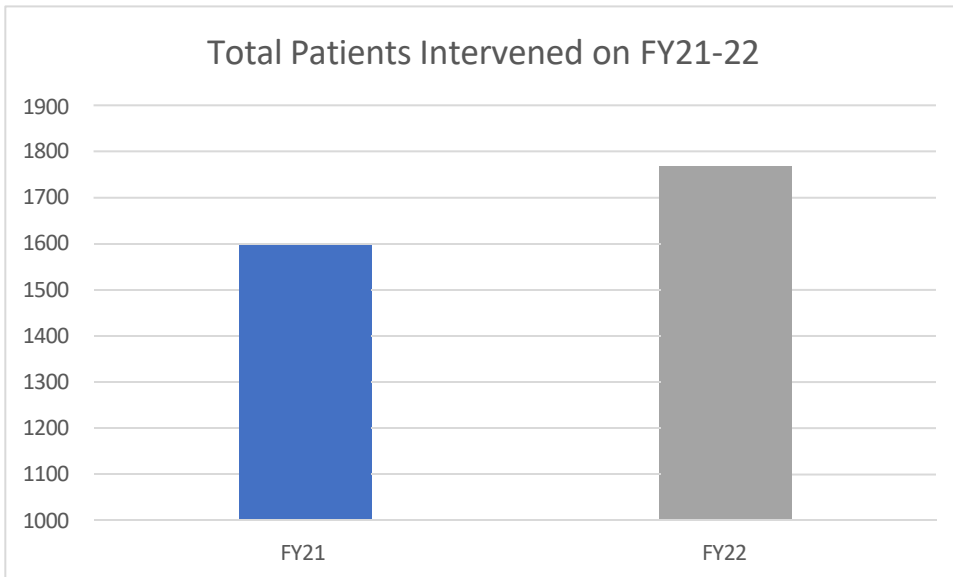
DOT per 1000 Patient Days

## Broad Spectrum Antibiotic DOTs For Each Campus Over Time

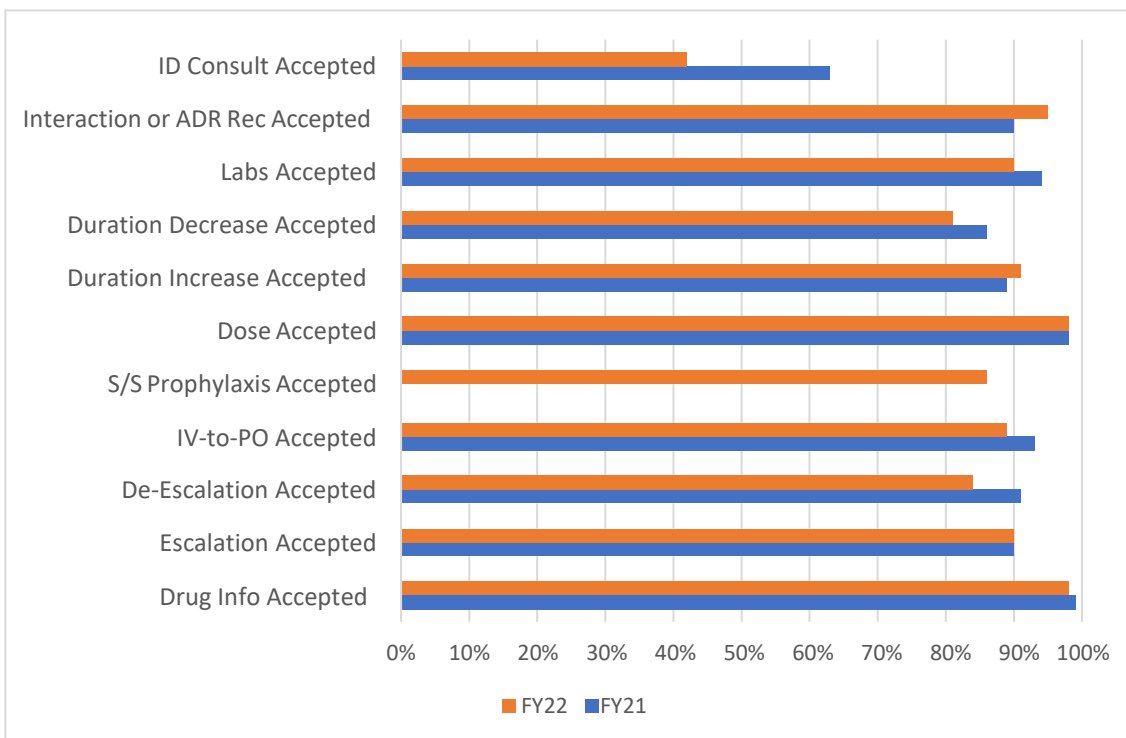
Broad Spectrum Antibiotics in Days of Therapy per 1000 Patient Days (Aztreo, Cefep, Cipro, Clinda, Erta, Levo, Linez, Mero, Pip-Tazo, Vanco IV)												
Campus	FY2017	FY17 --> FY18 Change	FY2018	FY18 --> FY19 Change	FY2019	FY19 --> FY20 Change	FY2020	FY20 --> FY21 Change	FY2021	FY21 --> FY22 Change	FY2022	Total Change
Allentown	308.40	-6.35%	288.83	-1.45%	284.65	-7.94%	262.06	-7.10%	243.45	-5.23%	230.72	-25.19%
Anderson	409.26	-5.64%	386.19	3.96%	401.48	-29.84%	281.68	-12.85%	245.49	-15.26%	208.04	-49.17%
Bethlehem	243.99	-10.62%	218.08	-4.02%	209.31	7.08%	224.14	9.05%	244.43	-9.37%	221.53	-9.21%
Carbon	-	-	-	-	-	-	-	-	-	-	434.64	-
Easton	-	-	-	-	-	-	-	-	460.33	5.20%	484.28	5.20%
Lehighton	-	-	-	-	269.40	-9.68%	243.31	-9.39%	220.46	-32.07%	149.76	-44.41%
Miners	782.16	-12.41%	685.09	-4.79%	652.25	-3.02%	632.57	-6.49%	591.49	-11.37%	524.26	-32.97%
Monroe	553.06	-14.40%	473.43	-6.22%	443.98	-14.29%	380.53	-4.11%	364.89	2.06%	372.40	-32.67%
Orwigsburg	-	-	-	-	-	-	502.15	-13.27%	435.53	-8.53%	398.37	-20.67%
Sacred Heart	-	-	-	-	97.66	-30.27%	68.10	-20.54%	54.11	20.26%	65.07	-33.37%
Upper Bucks	425.89	-2.02%	417.30	-8.32%	382.57	-6.42%	358.00	-1.81%	351.52	1.78%	357.76	-16.00%
Warren	630.01	-3.86%	605.71	-10.35%	543.04	-14.49%	464.37	-7.69%	428.64	-4.80%	408.07	-35.23%
Network	-	-	331.31	-11.94%	291.75	-9.09%	265.24	0.22%	265.83	-2.74%	258.54	-21.96%

## Total Patients Intervened on FY21-FY22

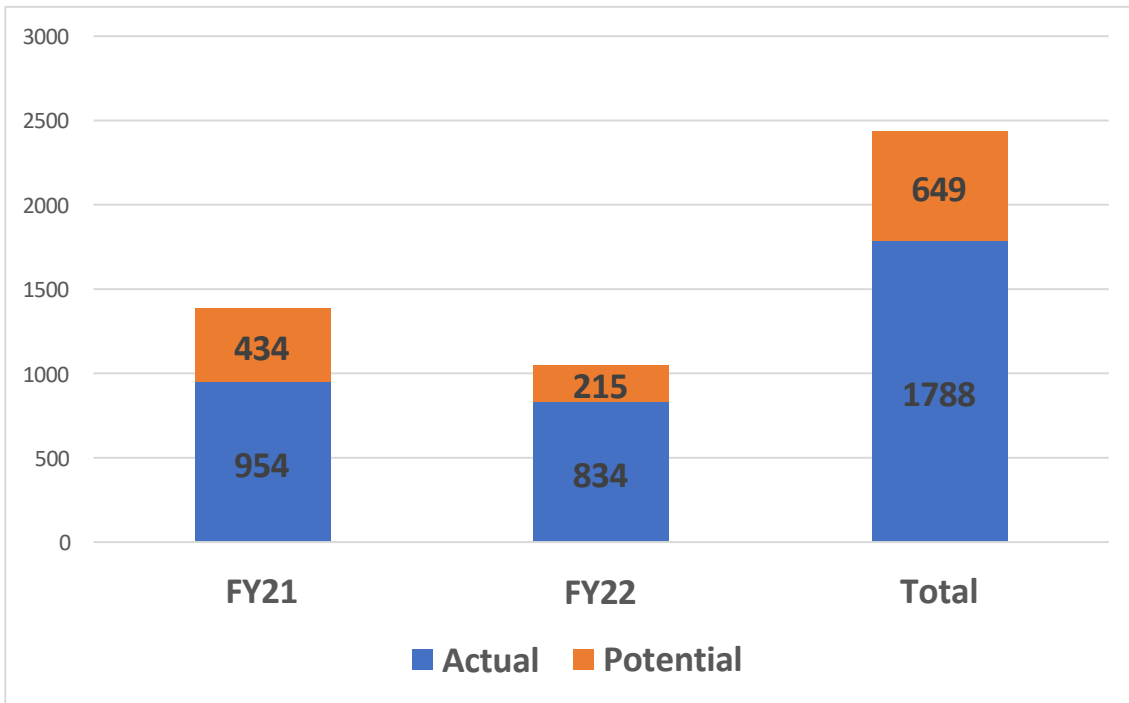




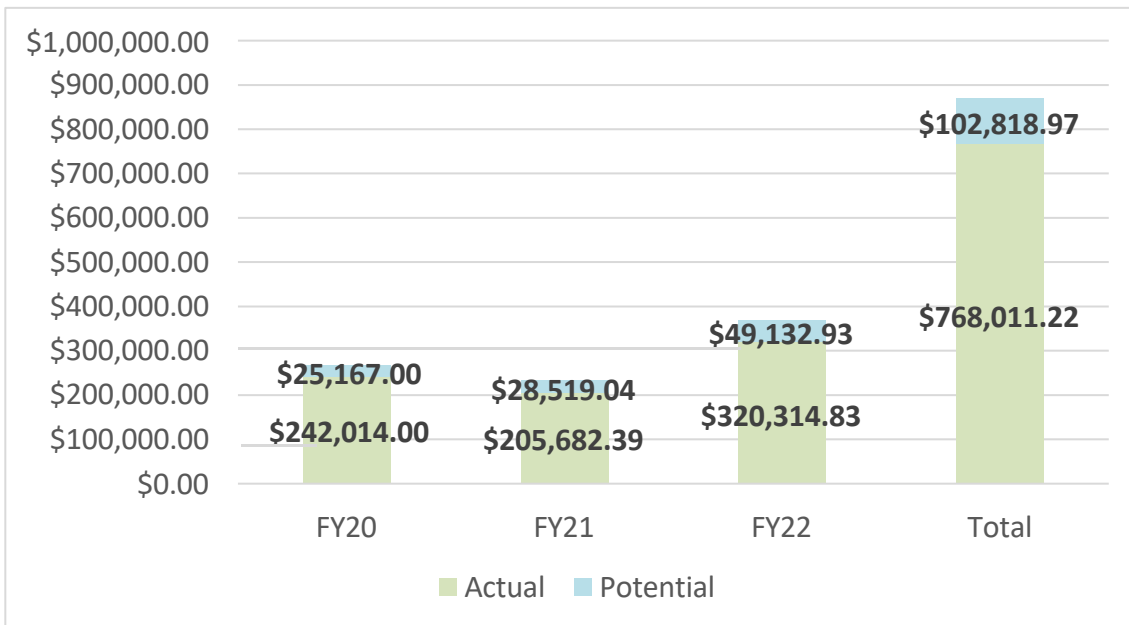
### Intervention Acceptance Rate Comparison Over Time



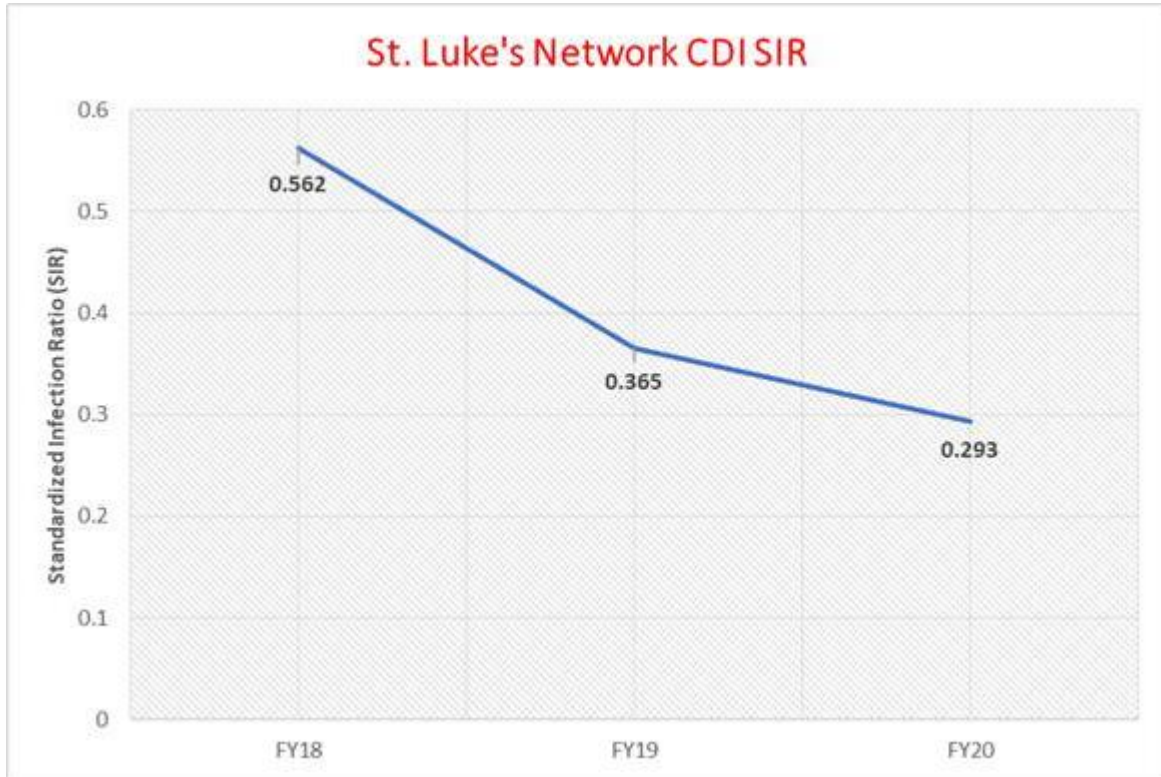
### Total Antimicrobial Duration of Therapy Saved via Interventions



### Total Antimicrobial Cost Savings Over Time via Interventions



## Network *Clostridioides Difficile* Infection (CID) Standardized Infection Ratio (SIR) Over Time



### ***Accountability and Driving Resilient Care Redesign***

In conjunction with our newly implemented 72-hour antibiotic timeout, providers are also notified whenever their patient meets criteria for an antibiotic de-escalation or bug-drug mismatch. This means that if either 1) the patient is on a broader antibiotic than is required based on the pathogen growing in microbiologic culture OR 2) the patient is on an antibiotic that is not actively treating the pathogen growing in microbiologic culture, providers are notified by a passive BPA and prompted to address the current antibiotic regimen.

Efforts by the St. Luke's AMS program are ongoing. Daily prospective review continues each day, and education continues to be offered and disseminated to multiple provider groups at all campuses. Interventions for FY23 are being compiled. DOT data for FY23 quarter 1 is also currently being tabulated. We are also looking at other data metrics to trend to identify areas for improvement.

The AMS program continues to prioritize additional projects and initiatives to further optimize antimicrobial prescribing. These include novel Bayesian software for enhanced vancomycin dosing and monitoring, treatment guidelines for a variety of infection types, and additional rapid diagnostics to aid in quicker antibiotic de-escalation.

In FY21, we observed an increase in vancomycin, cefepime, and Zosyn utilization via our broad-spectrum DOT metric. Previously, prospective chart review was conducted by ID physicians for patients in the SLB medical intensive care unit. It was identified that antibiotic utilization in the medical intensive care unit was under control thanks to two PGY-2 critical care pharmacists who also contribute to stewardship. To address the increase in vancomycin, cefepime, and Zosyn, the antimicrobial stewardship program refocused their efforts to target patients ordered vancomycin, cefepime, and zosyn in med-surg units. Antibiotic DOT for vancomycin, cefepime, and zosyn will continue to be monitored now that the prospective chart review workflow has been updated.



# ID MD Targeted Prospective Chart Review

