Beyond Band-Aids:

Building Bridges to Optimize Pediatric Sepsis Practice

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UTHealth Houston
McGovern Medical School
Children's Memorial Hermann Hospital

Our Mission

We are a non-profit, values-driven, community-owned health system dedicated to improving health.

Our Vision

To create healthier communities, now and for generations to come.

Our Values

- Community
- Compassion
- Courage
- Credibility

Our Service Commitment

We care for every member of our community by creating compassionate and personalized experiences.

Our Service Standards

- Safe
- Caring
- Personalized
- Efficient

Disclosure Statement

We have nothing to disclose concerning possible financial or personal relationships with commercial entities that may be referenced in this presentation.

Children's Memorial Hermann Hospital (CMHH)

- Level I Pediatric Trauma Center and Children's Surgery Center
- 332 beds
  - 138 Pediatric beds
    - 22 bed Pediatric ICU
    - 20 bed Heart center ICU
  - 118 Neonatal ICU beds (Level IV)
  - 76 Women's beds (Level IV)
- Annual data
  - 6100+ hospital admission
  - ~1200 discharges from PICU

Antimicrobial Stewardship Program (ASP) Structure

Program Mission

- To optimize clinical outcomes in patients with infections, while maximizing quality of care, minimizing unintended consequences of antimicrobial use, including the emergence of resistance, and ensuring cost-effectiveness

Team Roles/Responsibilities:

- Hospital leadership includes:
  - Executive sponsor, Chief Medical Officer, Director of Pharmacy, Director of Microbiology, Infection Prevention
- Accountability/Pharmacy Expertise:
  - Medical Director, CMHH: Michael Chang, MD
  - Pharmacy Lead, CMHH: Hoang Huynh, PharmD

Program Goals, FY2024:

- Implement DoseMeRx for vancomycin dosing in pediatric populations
- Participate in transition to Epic, including build out antimicrobial stewardship module and validations of drugs/order sets
- Determine plan to use and disseminate NHSN AU data
- Establish framework for evaluating antimicrobial waste for pediatric patients

Objectives

- Recall basic sepsis fundamental and guidelines
- Understand local antibiograms and antimicrobials usage at Children's Memorial Hermann Hospital (CMHH)
- Discuss retrospective resident project on evaluation of culture-negative community-onset sepsis (pre-intervention audit)
- Describe quality improvement project on optimizing antimicrobial usage for community-associated sepsis and initial data (intervention period)
- Summarize antimicrobial stewardship take-home points

1.2 million cases of childhood sepsis per year

80% community onset sepsis

Weiss SL, et al. Intensive Care Med. 2020 Feb;46(Suppl 1):10-67.
Magill SS, et al. Open Forum Infect Dis. 2023 May;10(5):ofad218.

Guideline Recommendations

Surviving Sepsis Campaign

- Empiric therapy should be broad and cover most likely pathogens
- Institutions should identify most appropriate empiric agent considering site of infection, age, local epidemiology, and host risk factors

National Institute for Health and Care Excellence

- Ceftriaxone is empiric agent of choice if no history of resistant organism

Weiss SL, et al. Intensive Care Med. 2020 Feb;46(Suppl 1):10-67.
© NICE (2017) Sepsis: recognition, diagnosis and early management. BJU Int. 2018 Apr;121(4):497-514.

IPSO Collaborative Insights

- Time to first dose of antibiotics delays
  - Why?
- Order of antibiotics administration
  - Why give vancomycin first?
- Why do we use so much cefepime?
  - Is there a difference in our sepsis patient populations?

If we make recommendations from an ASP standpoint, will that negatively affect sepsis outcomes?

Current Antimicrobial Antibiogram

Year 2022 – 2023

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General Pediatrics and ICUs Combined Antibiogram

Children's Memorial Hermann Texas Medical Center

CMHH Antibiogram Without NICU
Jan 2022 - Dec 2023

All specimen sources
Numbers in table denote percent susceptible

	# Isolates	Penicillins					Cephalosporins								Aminoglycosides			Quinolones		Miscellaneous				
		Ampicillin	Ampicillin-sulbactam	Penicillin	Piperacillin-tazobactam	Oxacillin / Nafcillin	Cefazolin	Ceftriaxone	Cefepime	Meropenem	Clindamycin	Daptomycin	Linezolid	Vancomycin	Gentamicin (c)	Tobramycin (c)	Amikacin (c)	Ciprofloxacin (c)	Levofloxacin (c)	Nitrofurantoin (a)	Rifampin (b)	TMP/SMX	Tetracycline
GRAM POSITIVE ORGANISMS																								
Enterococcus spp.	162	96					R	R	R					96					98	96		R	25
Staphylococcus aureus (MSSA and MRSA)	418					68	¥				78		100	100	87*				83		100	99	91
Staphylococcus aureus (MRSA)	136						R	R	R		76			100	68*				57		99	99	88
Staphylococcus epidermidis	91					33					44			100	69*				73		96	59	92
Staphylococcus spp. not *aureus*	73					64					54			100	86*				86		96	77	82
Streptococcus pneumoniae	39			75				95			94			100					100			58	
GRAM NEGATIVE ORGANISMS																								
Acinetobacter spp.	26		88						81	96						77	81	92	96				81
Citrobacter freundii	23	R	61		96		R	13	100	100					91	87	100	96	100			83	87
Citrobacter koseri	12	R	100		100		100	100	100	100					100	100	100	100	100			100	92
Enterobacter cloacae	62	R	33		77		R	R	89	98					100	98	98	100	98	43		90	97
Escherichia coli	513	36	46		83		61	84	85	100					85	86	99	82	84	96		62	64
Klebsiella aerogenes	26	R	54		92		R	31	96	96					96	96	96	96	100	23		96	96
Klebsiella oxytoca	46		65		85			80	87	98					87	87	98	89	96	100		87	85
Klebsiella pneumoniae	136	R	51		74		65	75	76	98					88	83	97	85	91	51		75	66
Morganella morganii	15	R	R		100		R		100	100					87	100	100	87	93	R		73	40
Proteus mirabilis	79	73	77		97		70	95	97	100					94	92	100	91	92	R		86	R
Pseudomonas aeruginosa	224	R	R		90		R	R	84	89					74	83	90	91				R	R
Serratia marcescens	100	R	12		64		R	R	95	96					93	83	94	94	99	R		97	
Stenotrophomonas maltophilia	88	R	R	R	R		R	R	R	R					R	R	R		94			100	

Antibiogram Analysis

Community-associated (CA) versus Hospital-onset (HO)

- Deeper dive into antibiogram data
  - CA bacteria = 700+
  - HO bacteria = 300+
- The majority of bacteria from patients with CA-sepsis or cultures were from *E. coli*, *Klebsiella*, *Enterobacter*
- *Pseudomonas* and *Serratia* almost all from patients with significant medical history, which is the cause of HO-sepsis

Bacteria	Isolates #	CA vs HO
Enterobacter cloacae	62	CA
Escherichia coli	513	CA
Klebsiella pneumoniae	136	CA
Pseudomonas aeruginosas	224	HO
Serratia marcescens	100	HO

Rationales

We focused on CA-sepsis, based on our discussions with our local IPSO team

- Cefepime and ceftriaxone have similar resistance patterns for bacteria of interest
- Ceftriaxone has potential benefits for sepsis patients
  - Volume difference
  - Frequency of administration
  - Burden on pharmacy and nursing
- Simplifying and streamlining interventions for sepsis patients could help with mental load, task burdens

Optimizing Empiric Antibiotic Selection for Culture Negative Community-Onset Sepsis in Pediatric Patients

Jessica Tranchina, PharmD

PGY2 Pediatric Pharmacy Resident

Collaborators: Hoang Huynh, PharmD; Shannan Eades, PharmD; and Michael L. Chang, MD

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Background

Cefepime is used most often at Children's Memorial Hermann Hospital (CMHH)

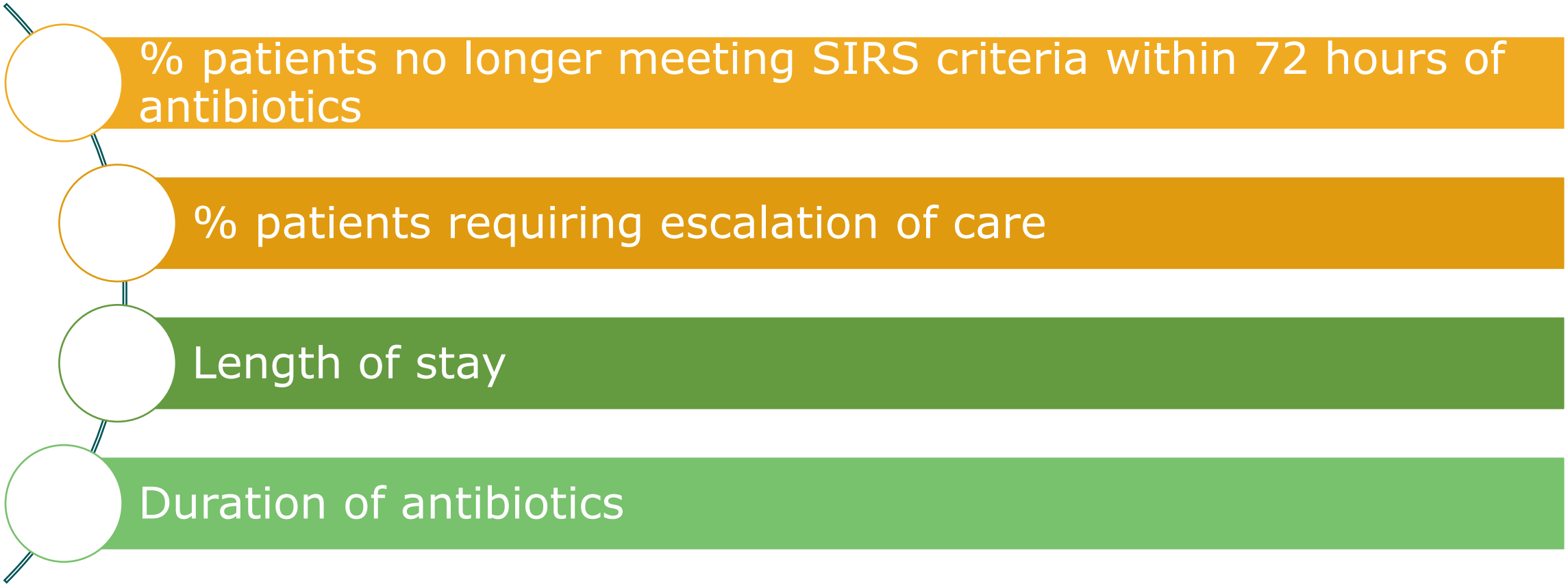
No cultures were positive for *Pseudomonas spp.* over a two year period

100% of blood and urine isolates resistant to ceftriaxone were also resistant to cefepime in 2022

Study Objective

Determine if there is a difference between ceftriaxone and cefepime for the empiric treatment of culture negative community onset sepsis in pediatric patients

Project Aims



SIRS = Systemic inflammatory response syndrome

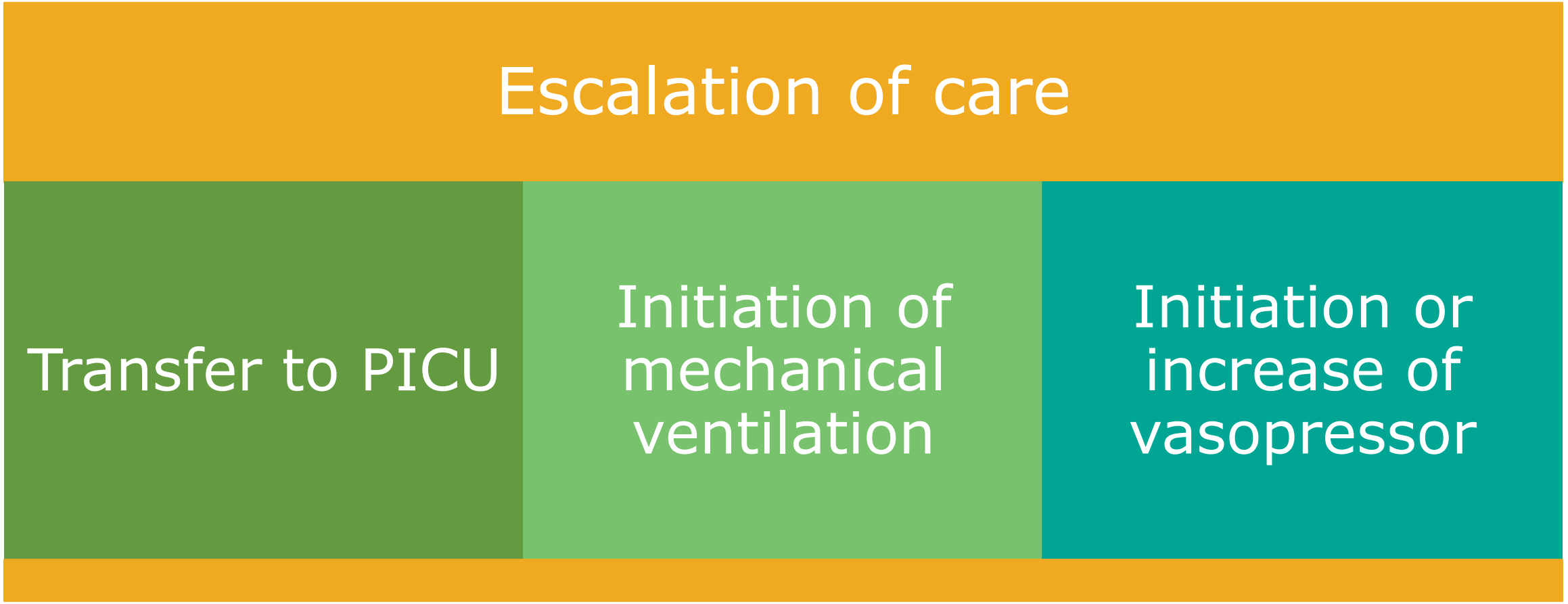
Definitions – SIRS Criteria

SIRS Criteria: ≥2 of the following

Heart rate (bpm)*	Respiratory rate (bpm)*	Leukocyte count ($10^3/mm^3$)*	Temperature (ºF)
			• <96.8ºF • >100.4ºF

*below or above age appropriate value
SIRS = Systemic inflammatory response syndrome; bpm = beats or breath per minute

Definitions – Escalation of Care



PICU = pediatric intensive care unit

Methods

Study Design

- Retrospective non-inferiority study

Study Period

- January 1, 2016 to November 30, 2023

Outcomes Measures

Primary

- % patients no longer meeting SIRS criteria within 72 hours of antibiotic

Secondary

- Time to fever resolution
- % patients with care escalation
- % patients with antibiotic escalation
- Duration of vasopressor support
- Length of stay
- Length of stay in PICU
- Duration of IV antibiotics
- Duration of all antibiotic therapy
- Time to PCT level <0.25 ng/mL

SIRS = Systemic inflammatory response syndrome; PICU = pediatric intensive care unit; IV = intravenous; PCT = procalcitonin

Studies Criteria

Inclusion

- >1 month to <18 year of age
- Culture negative community onset sepsis
- Ceftriaxone or cefepime

Exclusion

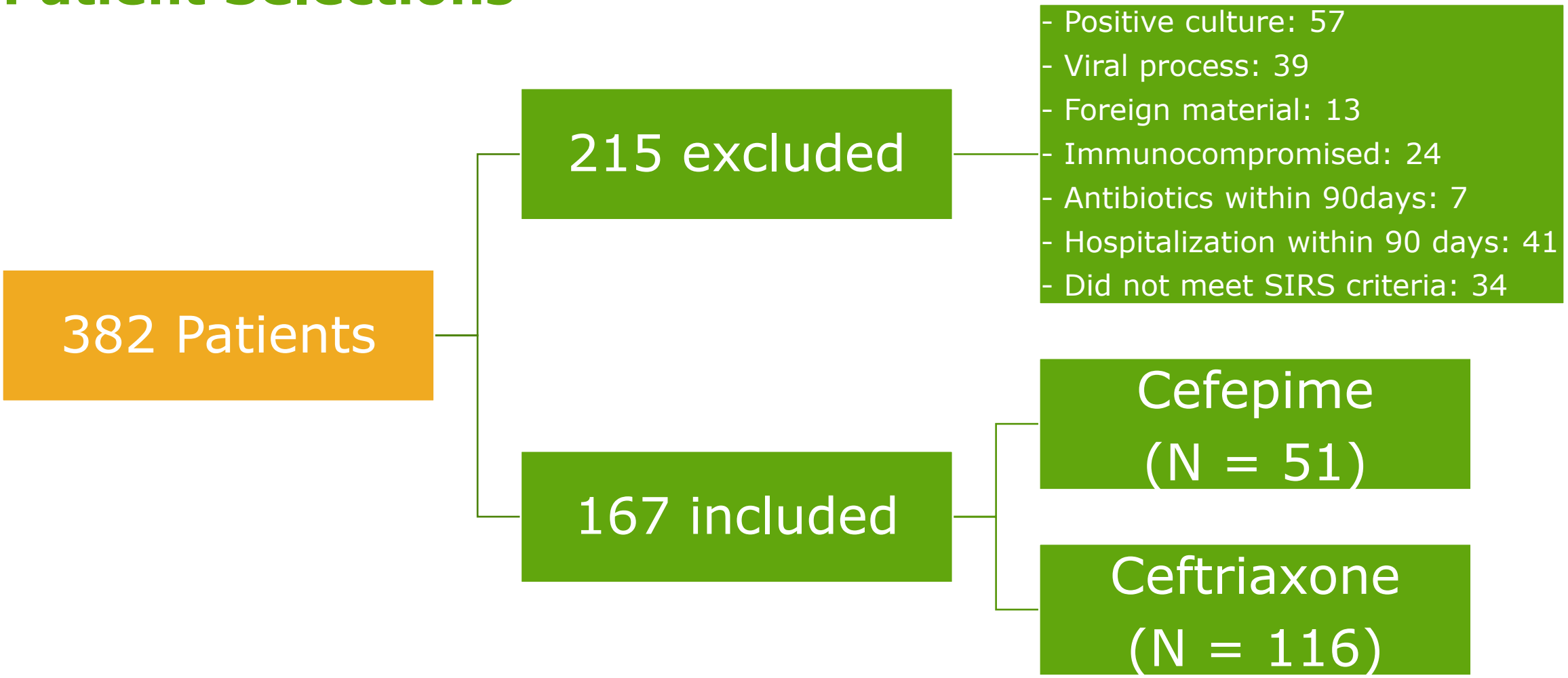
- Foreign devices
- Immunocompromised
- Recent hospitalization or IV antibiotics
- Positive culture
- Viral process + antibiotics ≤ 48 hours

IV = intravenous

Methods – Data Collection

Data Collection	
	Patient demographics
	Medication therapy
	Laboratory data
	Diagnostics
	Length of stay

Patient Selections



Demographics

Title	Cefepime (n = 51)	Ceftriaxone (n = 116)	P-value
Sex, n (%) **Male** **Female**	24 (47.1) 27 (52.9)	58 (50) 58 (50)	xx
Age (mo), median (IQR)	114 (127)	76 (129.3)	xx
Weight (kg), median (IQR)	33 (40.1)	25 (40.1)	xx
Height (cm), median (IQR)	138 (59.5)	121.5 (59.9)	xx
Allergy to cephalosporin, n (%)	0	0	N/A
Allergy to antibiotic, n (%)	4 (7.8)	6 (5.2)	xx
Additional antibiotics, n (%) **Yes** **No**	51 (100) 0	111 (95.7) 5 (4.3)	xx
Ventilator on admission, n (%)	25 (49)	17 (14.7)	xx

Project Progress and Plan

- Continue further data analysis and finalize results
  - Reviewing limitations of study
- Project platform presentation at PPA Annual Meeting – PediaRxCon 33 in May 2024
- Data once finalized will be presented to local Sepsis Community of Practice
- Potential incorporating data into quarterly interventions to targeted providers
  - PICU attending physicians and fellows
  - Emergency Medicine providers and fellows
  - Hospitalists and fellow

Optimizing Empiric β-Lactam Antibiotic Selection for Pediatric Patients with Community-Associated Sepsis

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Aim and Objectives

Aim:

- To improve selection of β-lactam antibiotics for empiric therapy for pediatric patients with community-associated sepsis admitted to the PICU at CMHH utilizing educational intervention to multiple groups of providers

Objectives:

- Define NHSN AU SAAR data
- Educate providers on broad spectrum vs narrow spectrum antimicrobials usage data
- Lay out plans for continue reporting to the group to track progress of education initiative

Standardized Antimicrobial Administration Ratio (SAAR)

Definition:

- A summary measure of antimicrobial use (AU) available to acute care hospitals participating in the AU Option of the National Healthcare Safety Network (NHSN) Antimicrobial Use and Resistance (AUR) Module.
- SAAR is calculated by dividing the number of observed antimicrobial days (also called antimicrobial days of therapy [DOT]) by the number of predicted antimicrobial days

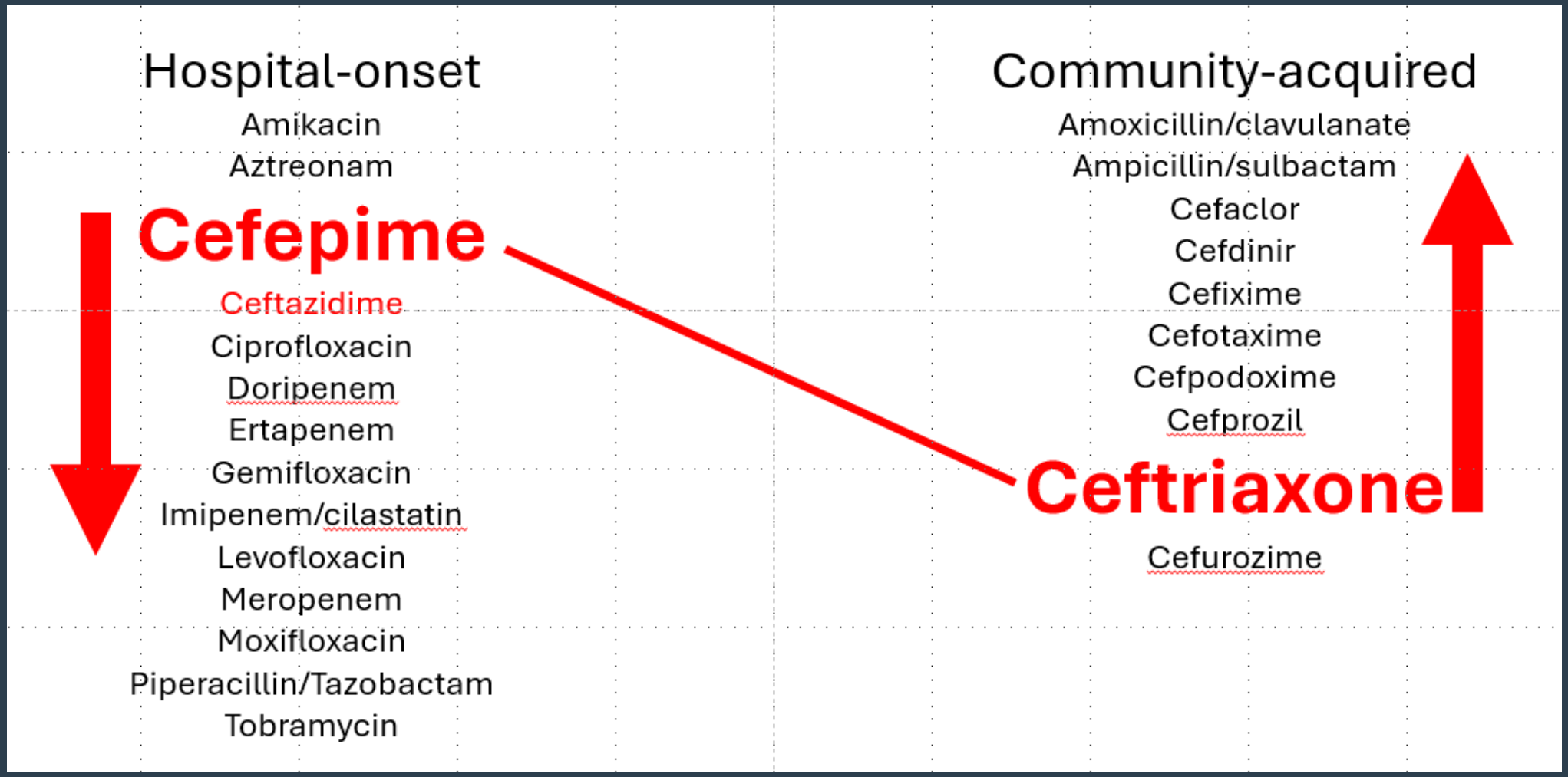
Ideally: Goal of SAAR = 1

Our focus is currently on 2 categories for antimicrobials usage - SAAR

- Broad spectrum antibiotics for hospital onset (BSHO) infections
- Broad spectrum antibiotics for community acquired (BSCA) infections

$$SAAR = \frac{Observed\ Antimicrobial\ Use}{Predicted\ Antimicrobial\ Use}$$

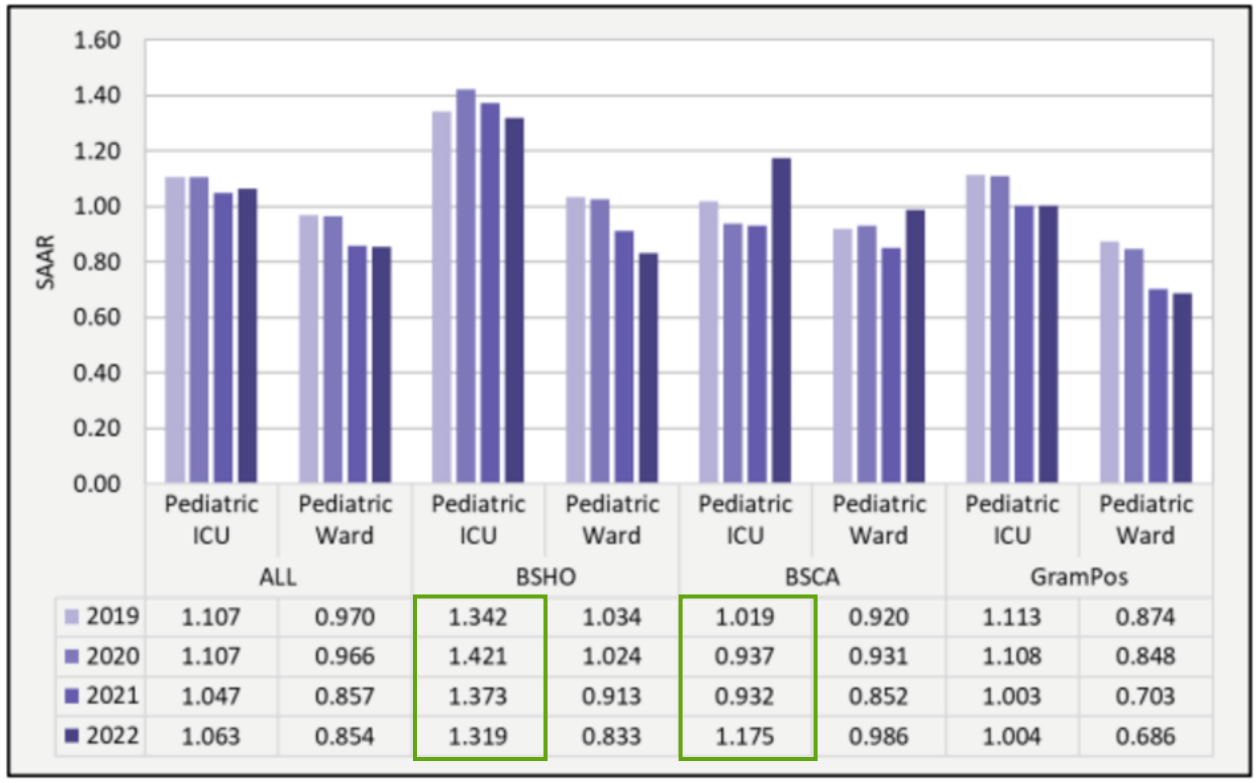
Antimicrobial Groupings for SAAR (Outcome measure)



National SAAR 2019 – 2022 Data

- Nationally, Pediatric Intensive Care Unit (PICU) are >1
  - For target BSHO, CDC NHSN national data summary shows SAARs around 1.3-1.4 for PICUs
  - Question 1: Are all PICUs using more antimicrobials than suggested?
  - Question 2: How is CMHH PICU compared to the rest of the nation?

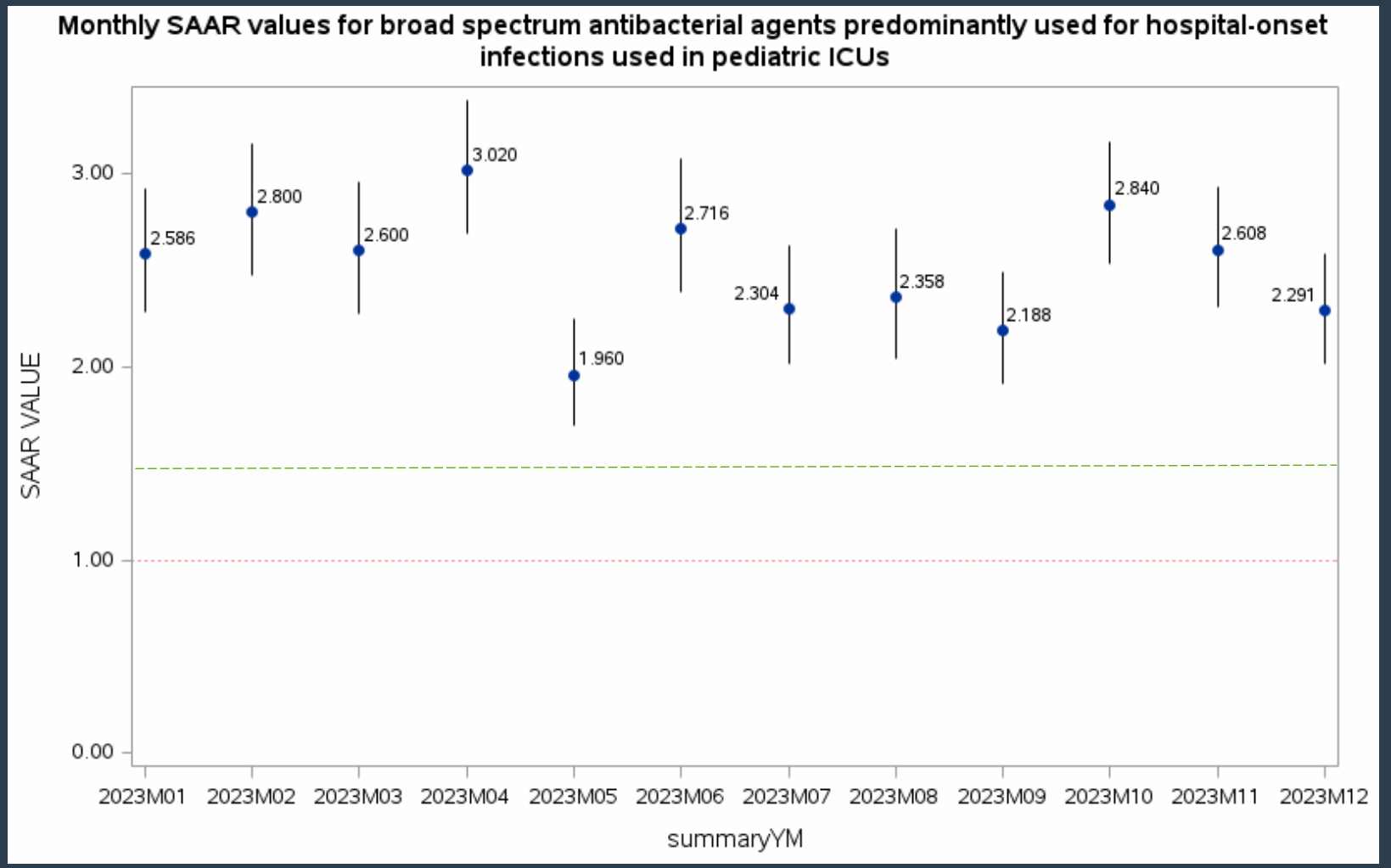
Figure 2b. Select 2019, 2020, 2021, and 2022 pooled mean SAARs, by antimicrobial agent category for pediatric ICUs and wards



	ALL		BSHO		BSCA		GramPos	
	Pediatric ICU	Pediatric Ward	Pediatric ICU	Pediatric Ward	Pediatric ICU	Pediatric Ward	Pediatric ICU	Pediatric Ward
2019	1.107	0.970	1.342	1.034	1.019	0.920	1.113	0.874
2020	1.107	0.966	1.421	1.024	0.937	0.931	1.108	0.848
2021	1.047	0.857	1.373	0.913	0.932	0.852	1.003	0.703
2022	1.063	0.854	1.319	0.833	1.175	0.986	1.004	0.686

CMHH PICU BSHO Plot

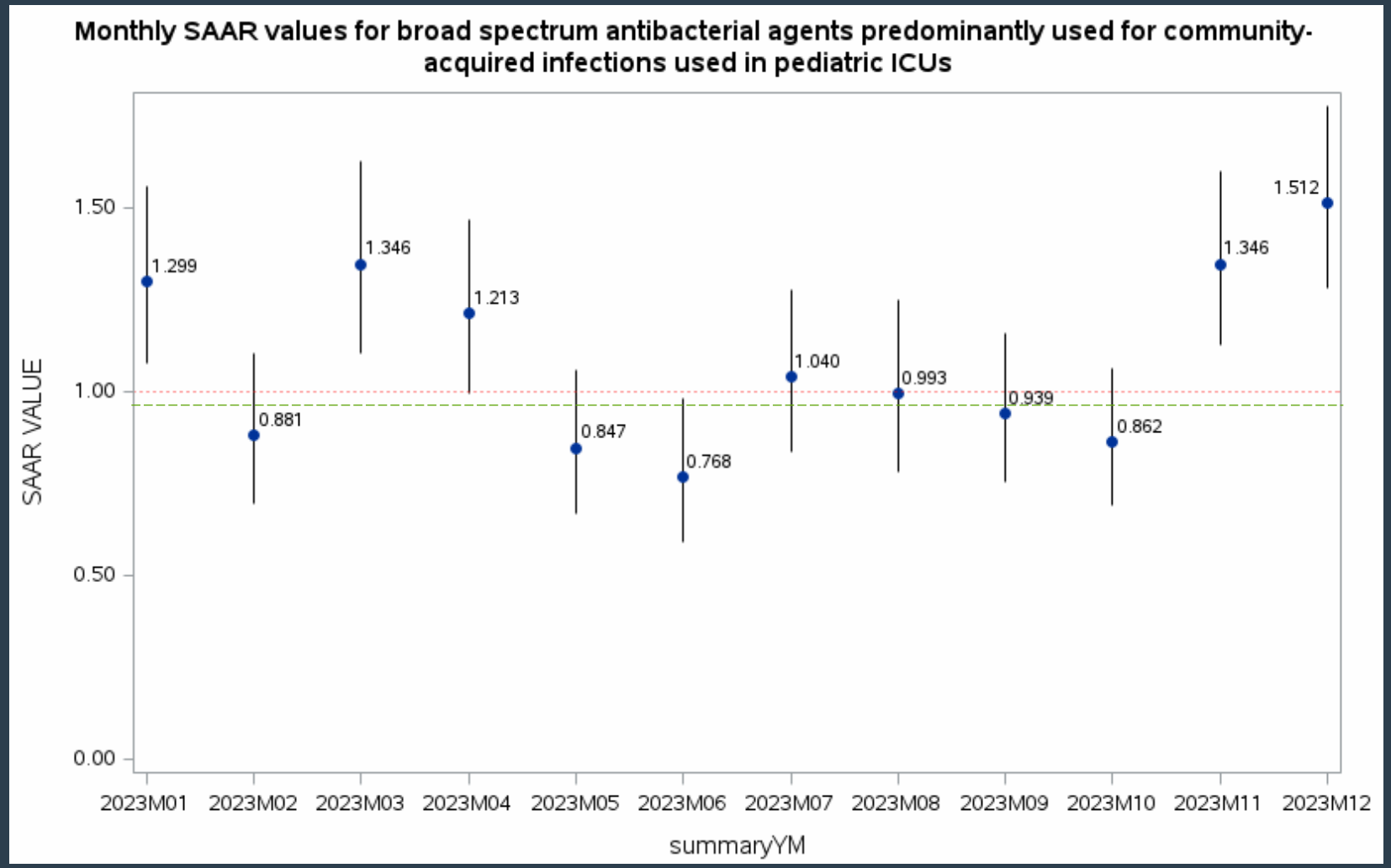
GOAL



National SAAR

CMHH PICU BSCA Plot

GOAL



National SAAR

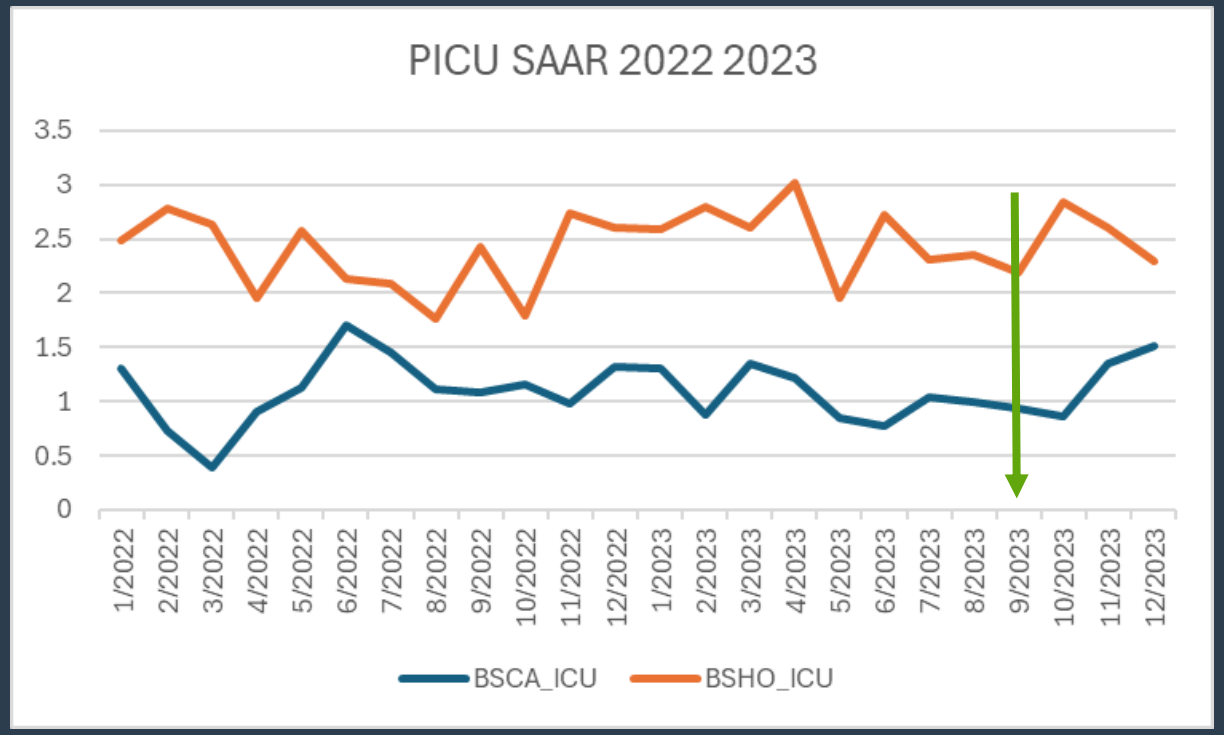
Project Goals

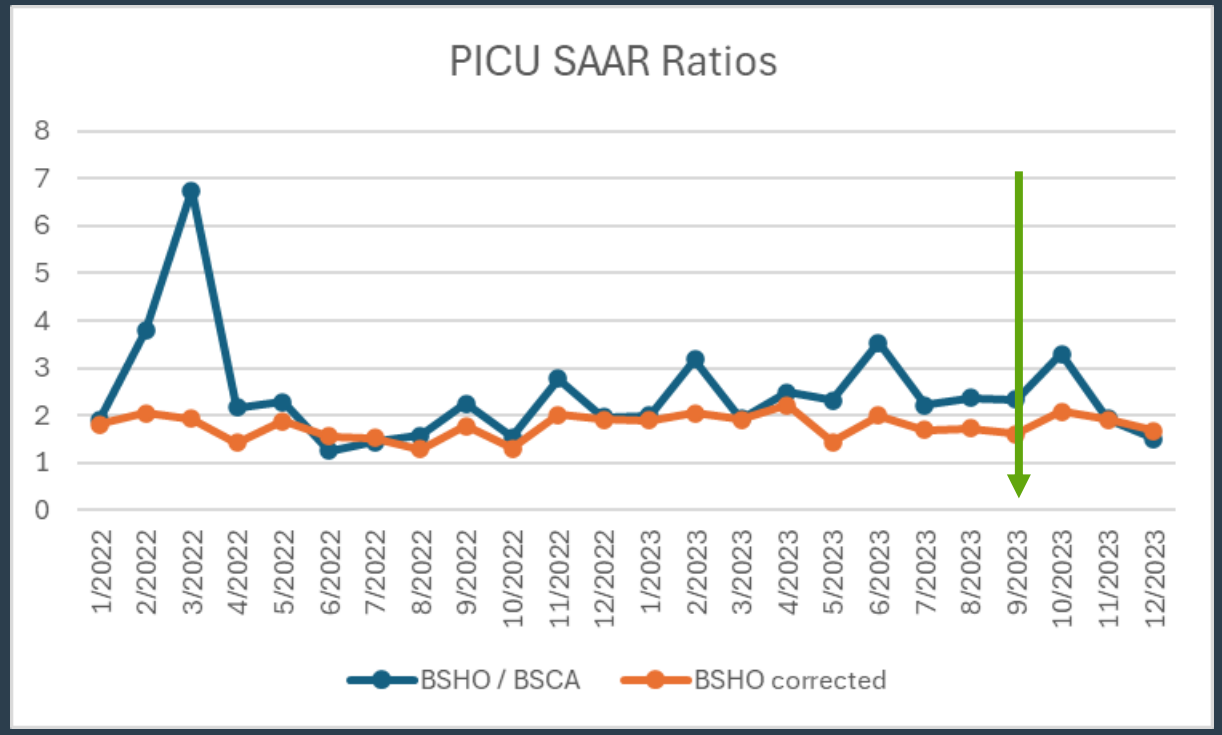
Decrease CMHH cefepime SAAR towards expected ratio of 1 through prescriber behavior for empiric β-lactam selection for pediatric patients admitted to our PICU for community-associated sepsis

Increase CMHH ceftriaxone SAAR towards expected ratio of 1 through prescriber behavior for empiric β-lactam selection for pediatric patients admitted to our PICU for community-associated sepsis

Obtain qualitative feedback of the effectiveness of the educational intervention in order to improve the sustainability of change through education, by applying targeted improvements for multiple audiences

Intervention 1: Didactic Lecture to PICU Faculties and Fellows – 9/14/2024





Lessons Learned – Cycle 1 analysis

Lessons learned from intervention 1

- Didactic lecture to PICU faculty and fellows 9/14/2024
  - Significant increase in patient volume and acuity lead to reversion to prior / accustomed behavior
    - Cycle 1 occurred during respiratory infection season
  - Confusion regarding community-associated sepsis patient definitions
  - Waning recall of education
  - Lack of timely feedback on performance

Next Steps

Intervention 2 with PICU

- Repeat didactic presentation scheduled on 4/5/2024
  - Exiting respiratory viral season, potentially different case mix in PICU
- Bimonthly SAAR feedback to division

Intervention 3 with Pediatric Emergency Medicine

- Didactic presentation scheduled on 4/21/2024

Take Away Points

Antimicrobial Stewardship Pearls

- Use your local data to influence and guide prescriber behavior
- Regular feedback and communication are critical
- It takes a multidisciplinary team to effectively implement change

Thank You

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