Evaluation of Antibiotic Management for Pediatric Patients with a Positive Sepsis Screen

Jessica Young, PharmD
Jessica Miller, PharmD, BCIDP
Karen Caylor, PharmD, BCPS
Ronda Oram, MD

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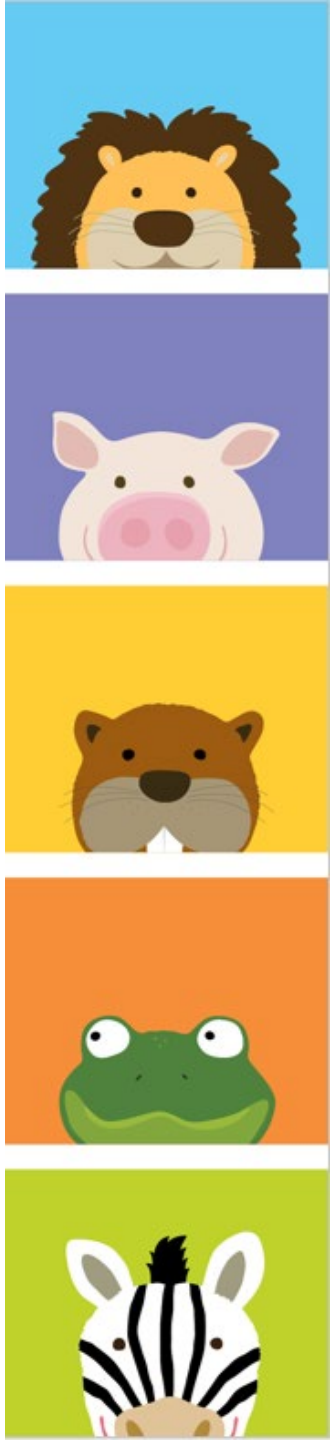
Pediatric Sepsis

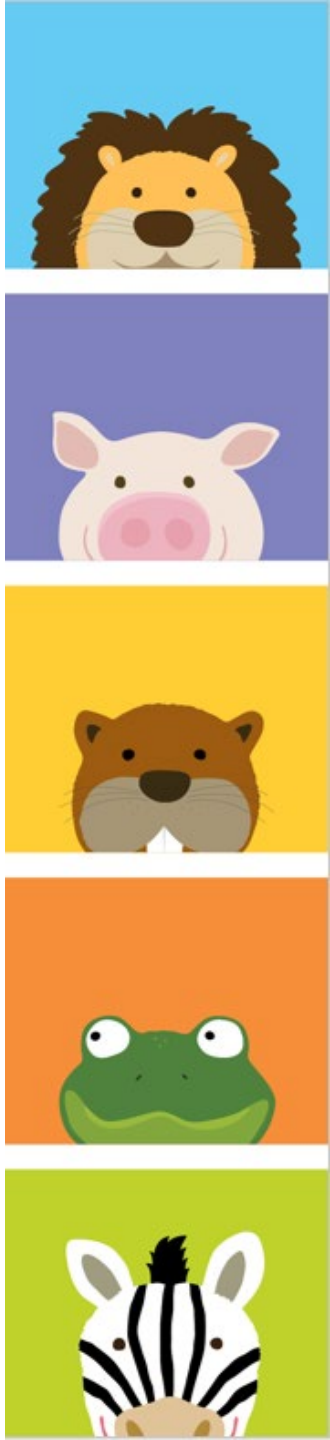
- Estimated 3.3 million deaths worldwide yearly
- Life-threatening condition caused by body's response to infection
- Importance of implementation of sepsis screening tools for timely recognition
- Initial treatment with broad-spectrum antibiotics to cover all likely pathogens



Weiss et al. *Pediatric Critical Care Medicine*. 2020
Sanchez-Pinto et al. *JAMA*. 2024

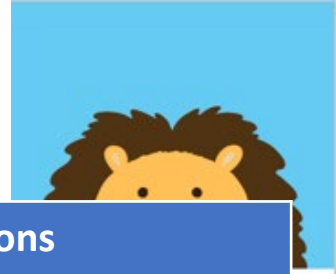
Pediatric Sepsis Screening Tools

- Implementation of sepsis alerts shown to improve recognition of sepsis in pediatric patients
  - Improved outcomes in both the emergency department and inpatient settings
- Based on vital signs or other easily obtainable parameters coupled with physician assessment
- Can be paired with multidisciplinary huddle or initiation of sepsis bundle



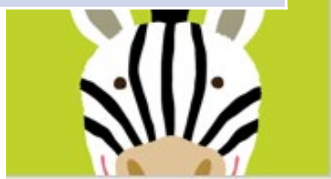
Balamuth et al. *Ann Emerg Med*. 2017
Gibbs et al. *Appl Clin Inform*. 2021
Martinez et al. *J Healthc Qual*. 2023
Oddiri et al. *Hosp Pediatr*. 2023

Sepsis Screening – Antibiotic Utilization

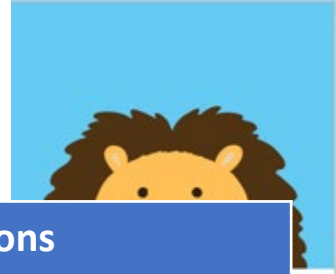


Study	Design/Population	Methods/Objectives	Results/Conclusions
Watanabe et al. (2017)	• Retrospective review • Adult inpatients with documented sepsis notification to clinician	• Sepsis alert based on vital signs/lab parameters • Impact of sepsis alert on physician decision making analyzed ○ Fluid/antibiotic management	• Initiation or change in current antibiotics occurred in 14% (14/100) of patients with **86% of changes (12/14) deemed unwarranted** • 98% (98/100) of sepsis alerts were not associated with true infections • **Sepsis alerts may lead to unnecessary antibiotic utilization**
Kang et al. (2021)	• Retrospective cohort study • Adult inpatients with nurse-triggered code sepsis activation	• Determine impact of sepsis activation on antimicrobial use and identify factors predictive of infection • Primary outcome: number of patients with antimicrobial escalation that was indicated and number of patients with confirmed infection	• Escalation of antimicrobial therapy occurred in 45.6% (246/529) of patients ○ **Indicated in 63.8% (157/246) of patients** • Infection identified in 67.6% (356/529) of patients • **Activation of Code Sepsis affects antimicrobial decision making which can lead to overuse**
Burston et al. (2017)	• Nonrandomized, controlled study • Adult patients with sepsis pathway triggered	• Evaluate impact of early infectious diseases antimicrobial stewardship intervention on inpatient sepsis antibiotic management • Antibiotic appropriateness determined at time of sepsis pathway trigger and 48 hours later	• In patients with triggered sepsis pathway, initial antibiotic **appropriateness occurred in 53% (80/152) of patients** and 58% (91/158) of patients had sepsis • Review of antibiotic therapy within 24 hours by infectious diseases team improved appropriateness at 48 hours (95% vs 76%, $p<0.01$) • **Delayed optimization of antimicrobials may reduce sepsis pathway effectiveness**

Watanabe et al. *OFID*. 2017
Kang et al. *Jt Comm J Qual Patient Saf.* 2021
Burston et al. *Infect Control Hosp Epidemiol.* 2017



Sepsis Screening – Antibiotic Utilization



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Kang et al. (2021)			**y** occurred in 45.6% **46) of patients** /529) of patients **antimicrobial** **o overuse**
Burston et al. (2017)	triggered	• Antibiotic appropriateness determined at time of sepsis pathway trigger and 48 hours later	athway, initial **ed in 53% (80/152)** patients had sepsis • Review of antibiotic therapy within 24 hours by infectious diseases team improved appropriateness at 48 hours (95% vs 76%, p<0.01) • **Delayed optimization of antimicrobials may reduce sepsis pathway effectiveness**

- Concern for sepsis alerts leading to overutilization of antibiotics
- Limited literature regarding appropriateness of antibiotic utilization at the time of sepsis alert/huddle (adult literature range 47-86%)

Watanabe et al. *OFID*. 2017
Kang et al. *Jt Comm J Qual Patient Saf.* 2021
Burston et al. *Infect Control Hosp Epidemiol.* 2017

Advocate Children's Hospital

- Park Ridge Campus
  - 19 bed PICU
  - 54 bed NICU
  - 56 bed general pediatrics unit
  - 12 bed pediatric emergency room

- Oak Lawn Campus
  - 24 bed PICU
  - 16 bed PCICU
  - 61 bed NICU
  - 49 bed general pediatrics unit
  - 22 bed pediatric emergency room

PICU: Pediatric Intensive Care Unit
NICU: Neonatal Intensive Care Unit
PCICU: Pediatric Cardiac Intensive Care Unit

Sepsis Screen & Huddle - ACH

Patient
(general pediatrics, emergency department)

Sepsis Screen Nursing Assessment
(every 4 hours)

Positive Sepsis Screen

Critical Kid Huddle

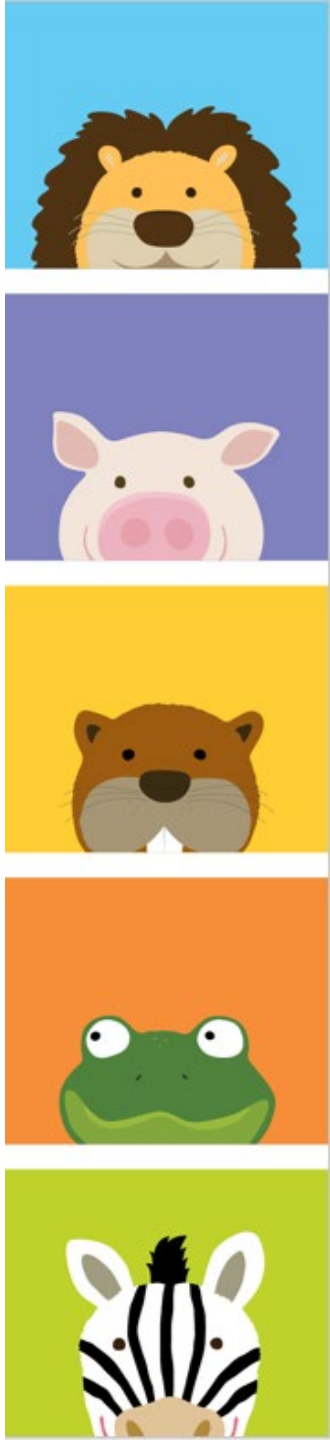
Sepsis Huddle Result
- Sepsis Watch
- Concern for Non-Severe Sepsis
- Concern for Severe Sepsis/Septic Shock

Negative Sepsis Screen

Continue Current Management

Sepsis Screen Nursing Assessment
- Temperature > 38.5 or < 36 °C + abnormal vital signs*
- Temperature 36 – 38.5°C + 2 abnormal vital signs*

*Heart rate, respiratory rate, blood pressure



Sepsis Stratification

Sepsis Watch

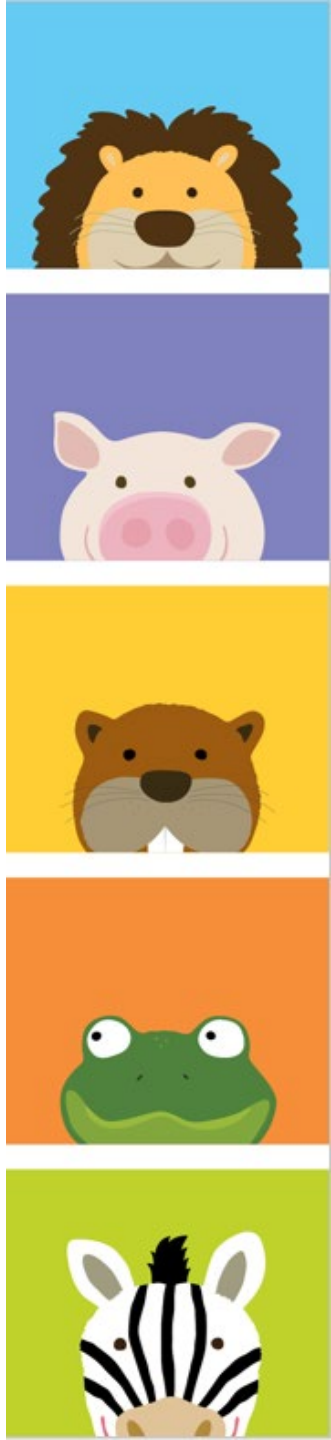
- Abnormal vitals but good perfusion and signs of another disease process
- Etiology likely viral, needs further evaluation
- Consider antibiotics if elevated white blood cells and/or procalcitonin

Non-Severe Sepsis

- Evidence of sepsis, abnormal vitals, known/suspected infectious source
- Initiate antibiotics within 1 hour

Severe Sepsis/Septic Shock

- Evidence of shock, abnormal vitals, poor perfusion, end organ dysfunction
- Initiate antibiotics within 1 hour

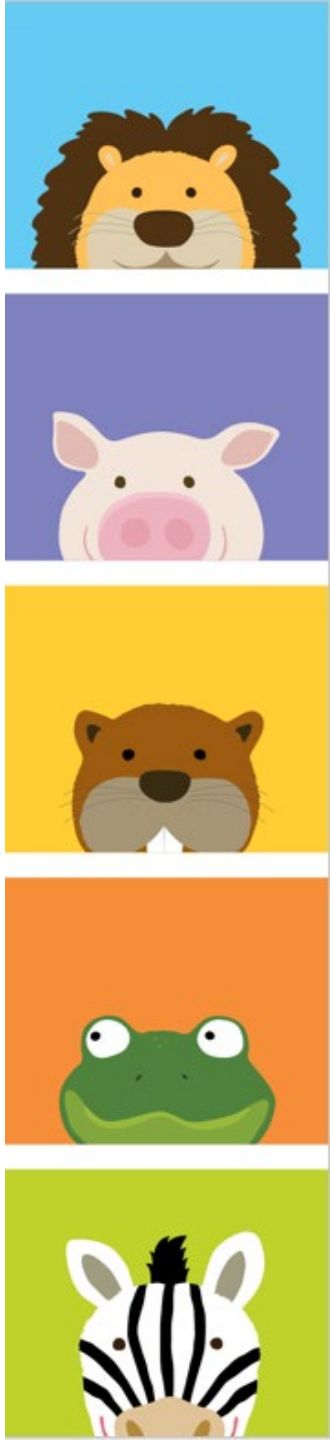


Methods

- Retrospective chart review

- **Inclusion Criteria**
  - Pediatric patients < 18 years old discharged from April 2023 to December 2023 from generated sepsis report for Advocate Children's Hospital (ACH) - Park Ridge and Oak Lawn campuses
    - Only included the first huddle per encounter per patient

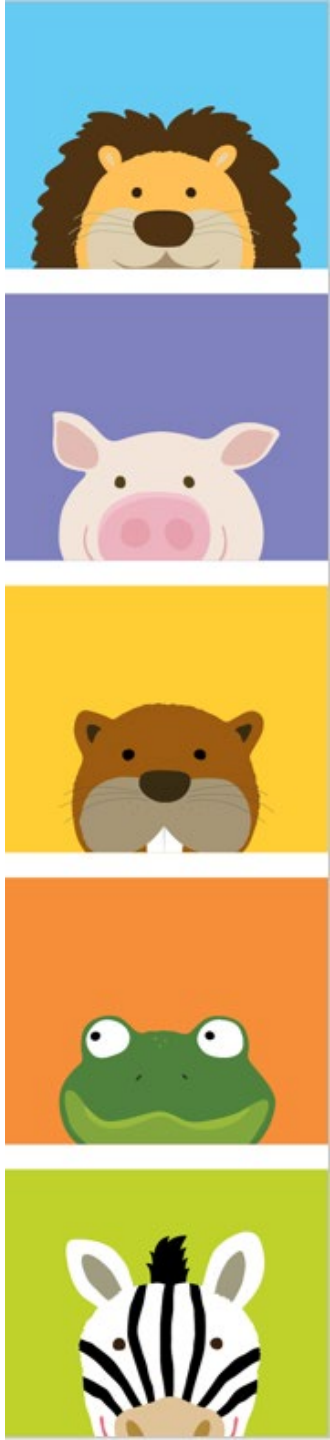
- **Exclusion Criteria**
  - No positive sepsis screen
  - No concern for sepsis at time of sepsis huddle
  - Location not on general pediatric units or emergency department



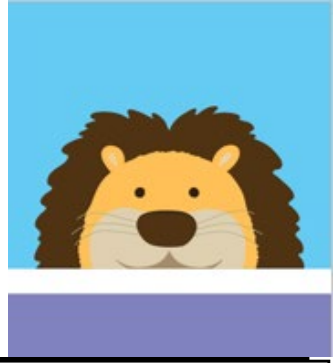
Methods

- **Primary Outcome**
  - Describe antibiotic use at the time of the sepsis huddle (new start, antibiotics continued, antibiotics changed, or antibiotics not started)

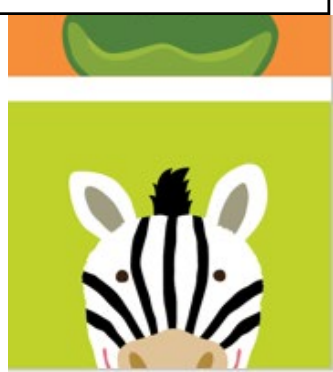
- **Secondary Outcomes**
  - Antibiotic appropriateness
    - Sepsis watch – determined based on ACH empiric use guideline recommendations based on source of infection
    - Concern for non-severe sepsis/septic shock – determined based on ACH sepsis recommendations
    - Unknown designation – determined based on sepsis recommendations
  - Duration of antibiotic therapy
  - Final diagnosis



Empiric Antibiotic Guidelines



Anatomic Site/ Diagnosis/ Population	Common Pathogens	Preferred Treatment	Comments
Sepsis (excludes NICU)			
Age ≤ 3 weeks or Age > 3 weeks and PMA < 40 weeks	*Streptococcus agalactiae* Gram negatives (*E. coli, Klebsiella* species), *Listeria monocytogenes* – rare	Ampicillin **plus** ceftazidime	Initiate IV antimicrobials when sepsis is a concern after cultures are drawn. Antimicrobials should be administered within 1 hour of suspicion of sepsis. If concern for *S. aureus* or severe sepsis/septic shock, add vancomycin. If concern for HSV, add acyclovir. If concern for abdominal source, add metronidazole or consider alternative therapy with piperacillin-tazobactam if non-meningitis source. If concern for Toxic Shock Syndrome, add clindamycin. High risk children include immunocompromised, febrile neutropenia, short gut, central line, s/p transplant If age ≤ 8 weeks, refer to *febrile infant pathway* for well-appearing febrile infants who do not have sepsis. **Strongly recommend ID consult.**
Age > 3 weeks and PMA ≥ 40 weeks (healthy children)	Gram negatives (*E. coli, Klebsiella* species), *S. pneumoniae, Moraxella, H. influenzae, N. meningitidis, S. aureus, S. pyogenes*	Ceftriaxone[Φ] +/- vancomycin	
Age > 3 weeks and PMA ≥ 40 weeks (high risk children)	Gram negatives (*E. coli, Klebsiella* species, P. aeruginosa), *S. pneumoniae, Moraxella, H. influenzae, N. meningitidis, S. aureus, S. pyogenes*	Cefepime +/- vancomycin	



HSV: herpes simplex virus
NICU: neonatal intensive care unit
PMA: postmenstrual age

Eligibility

508 encounters on sepsis report

211 encounters excluded
- Age
- Negative sepsis screen
- Not located in ED or General Pediatric Unit

297 encounters assessed with positive sepsis screens

32 encounters excluded due to no documentation

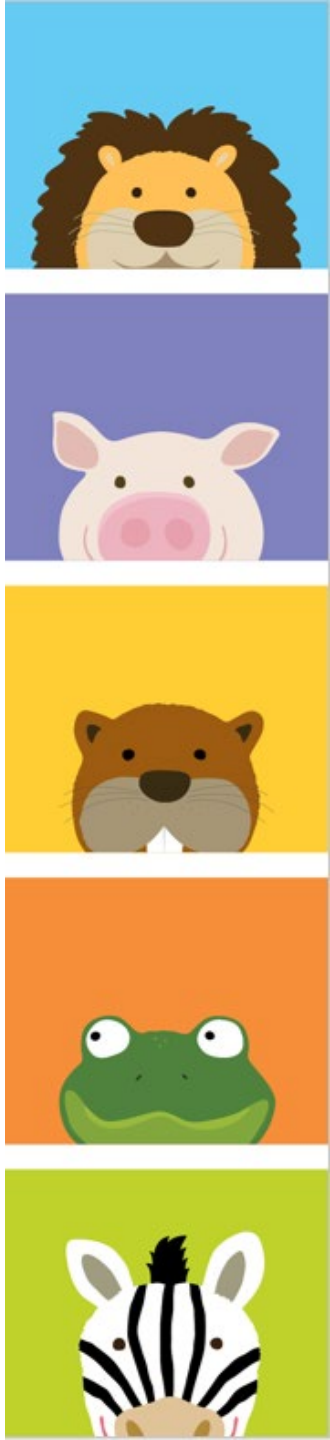
265 huddles evaluated

110 negative huddles excluded

155 positive huddles included

107 ED positive huddles

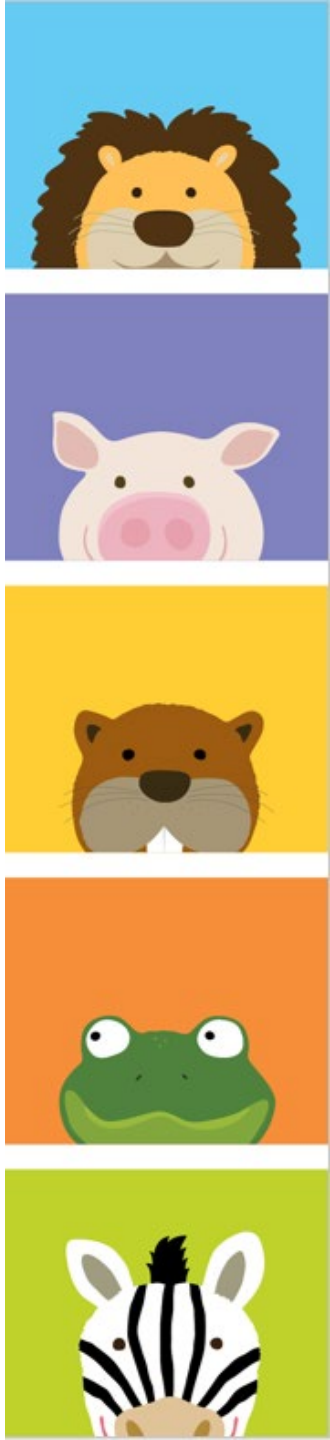
48 inpatient positive huddles



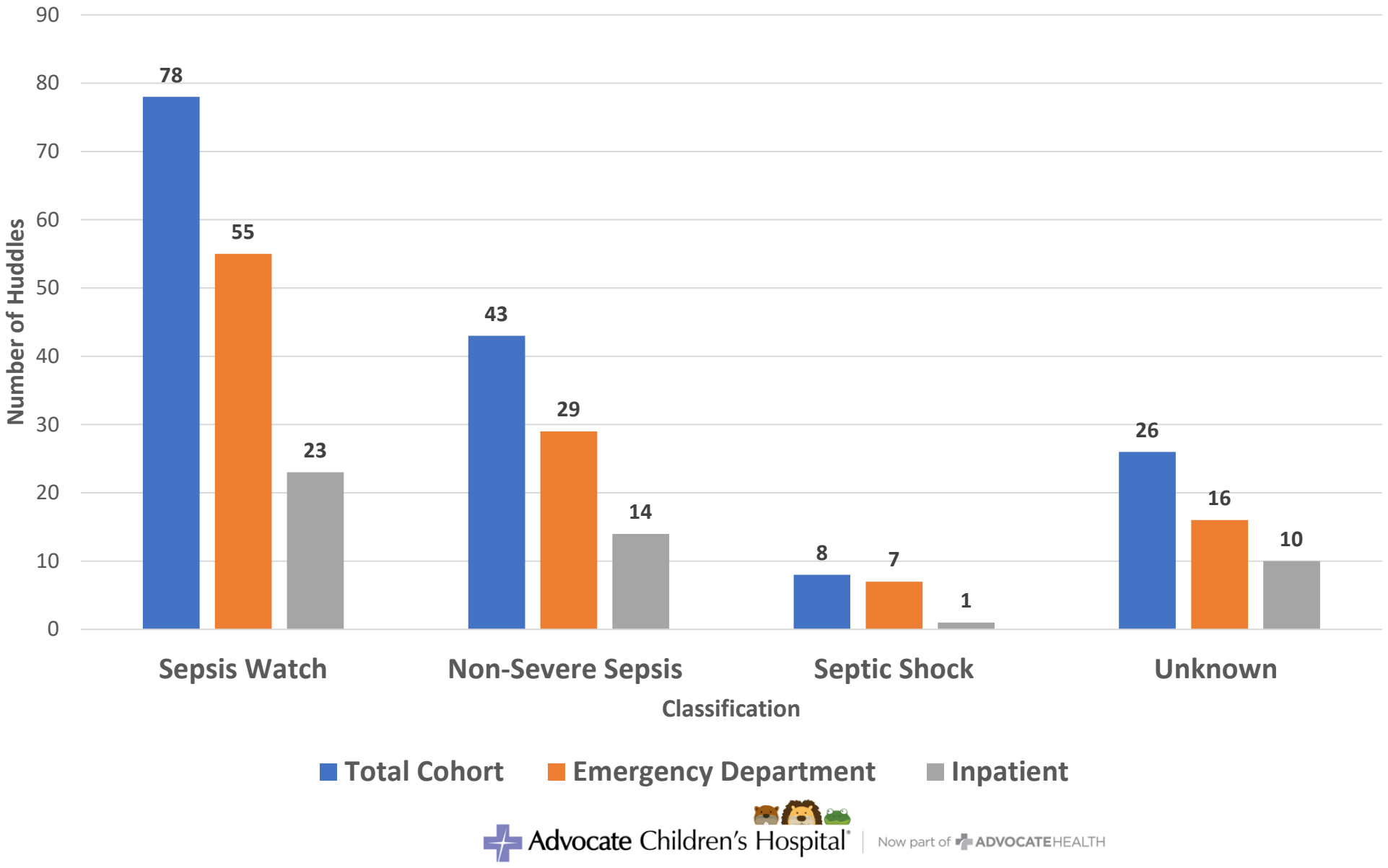
Baseline Characteristics

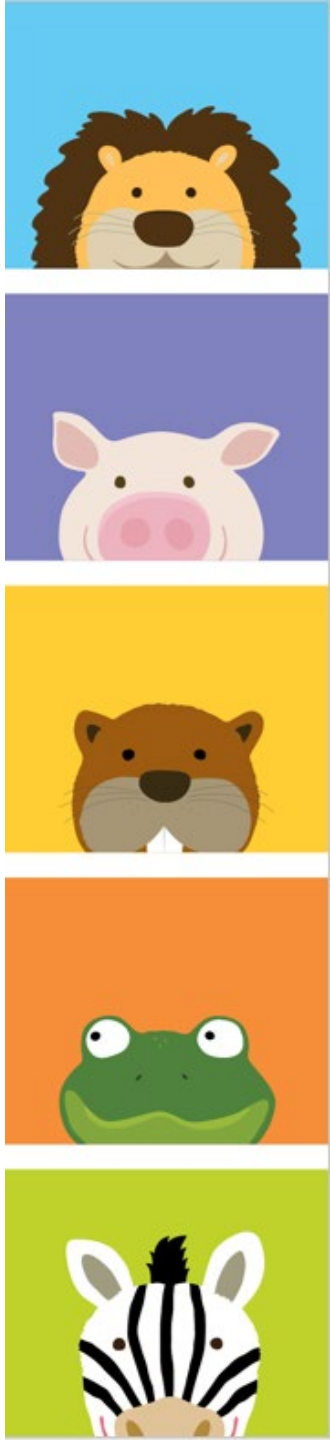
Characteristics	Results (n=155 Patients)
Male, n (%)	67 (43.2%)
Age (year), mean (range)	6.68 (0.041-17)
Immunocompromised*, n (%)	21 (13.5%)
ID Consult, n (%)**	21 (13.5%)
PICU Transfer*, n (%)**	46 (29.7%)

*immunocompromised defined as due to a disease, such as HIV/AIDS, or medications, such as chemotherapy or radiation for cancer, immunosuppressants for transplant organs, long-term corticosteroids or other drugs that suppress the immune system for a chronic condition
**before or consulted at time of the sepsis huddle
***at anytime during hospital encounter



Huddle Results by Designation





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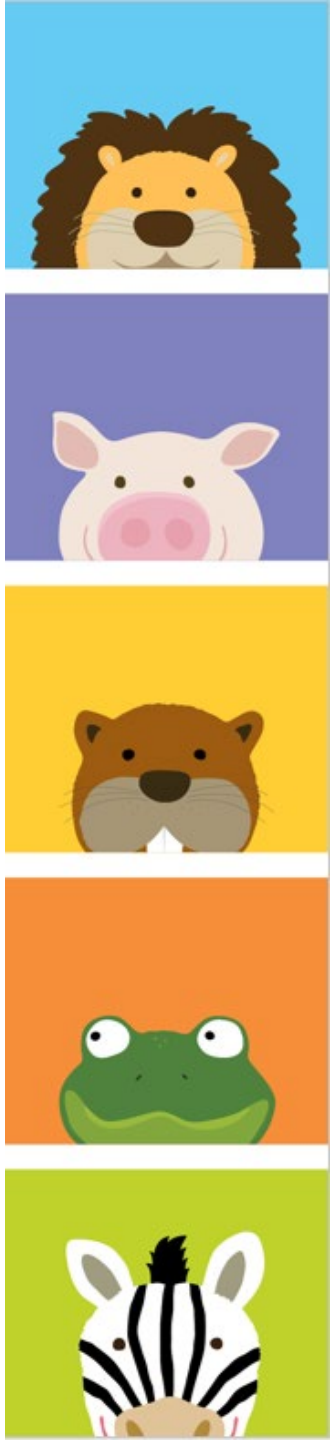
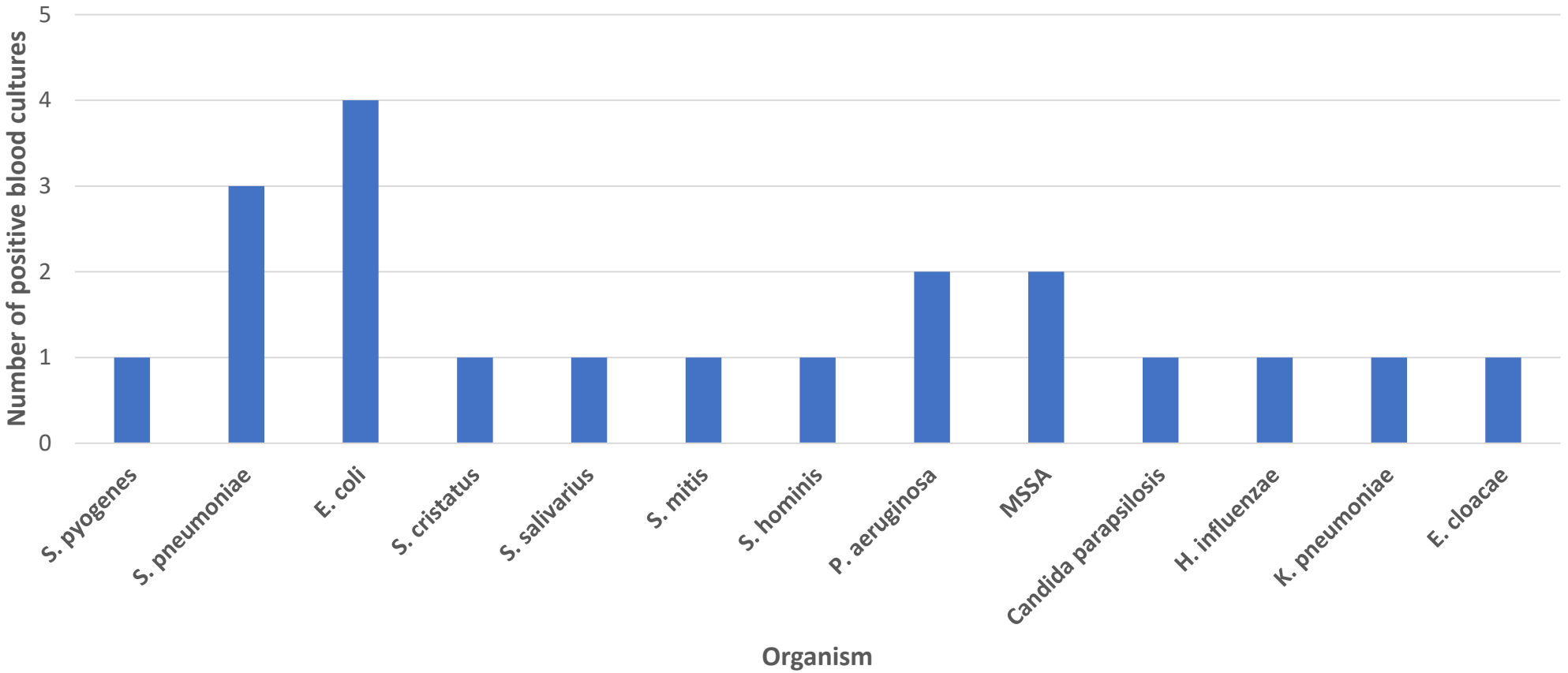
Diagnostic Testing

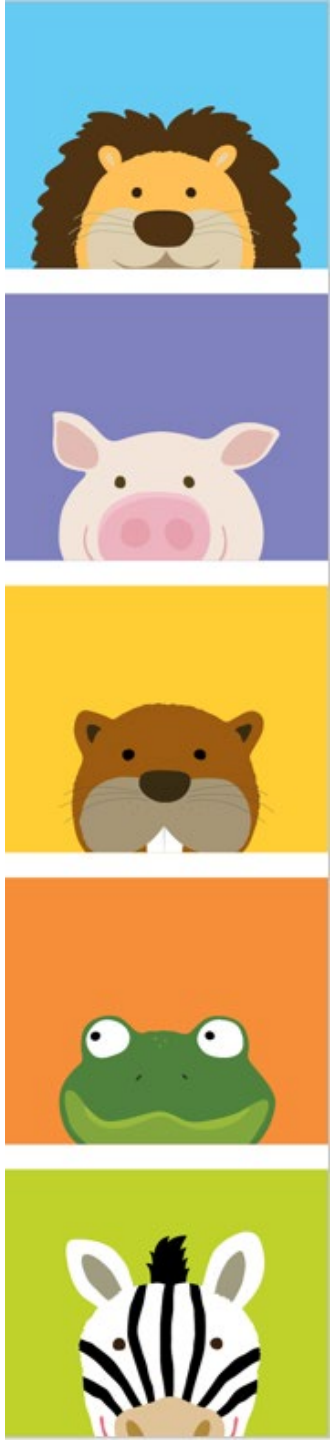
Within (+/-) 24 hours of huddle

Culture Obtained	Collected (n=155 Huddles)	Positivity
Blood, n (%)	143 (92.3%)	19/143 (13.3%)
Urine, n (%)	74 (47.7%)	16/74 (21.6%)
Respiratory, n (%)	6 (3.9%)	4/6 (66.7%)
Cerebrospinal fluid, n (%)	7 (4.5%)	1/7 (14.3%)



Blood Culture Results

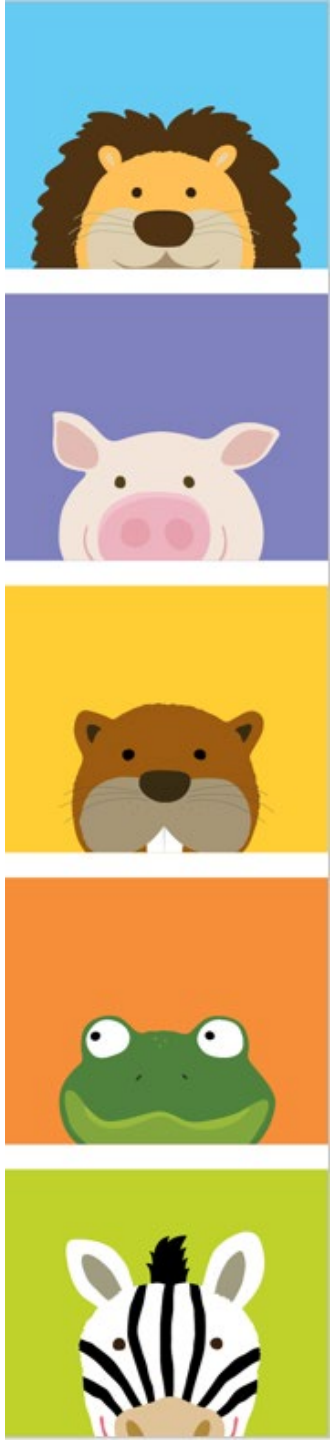




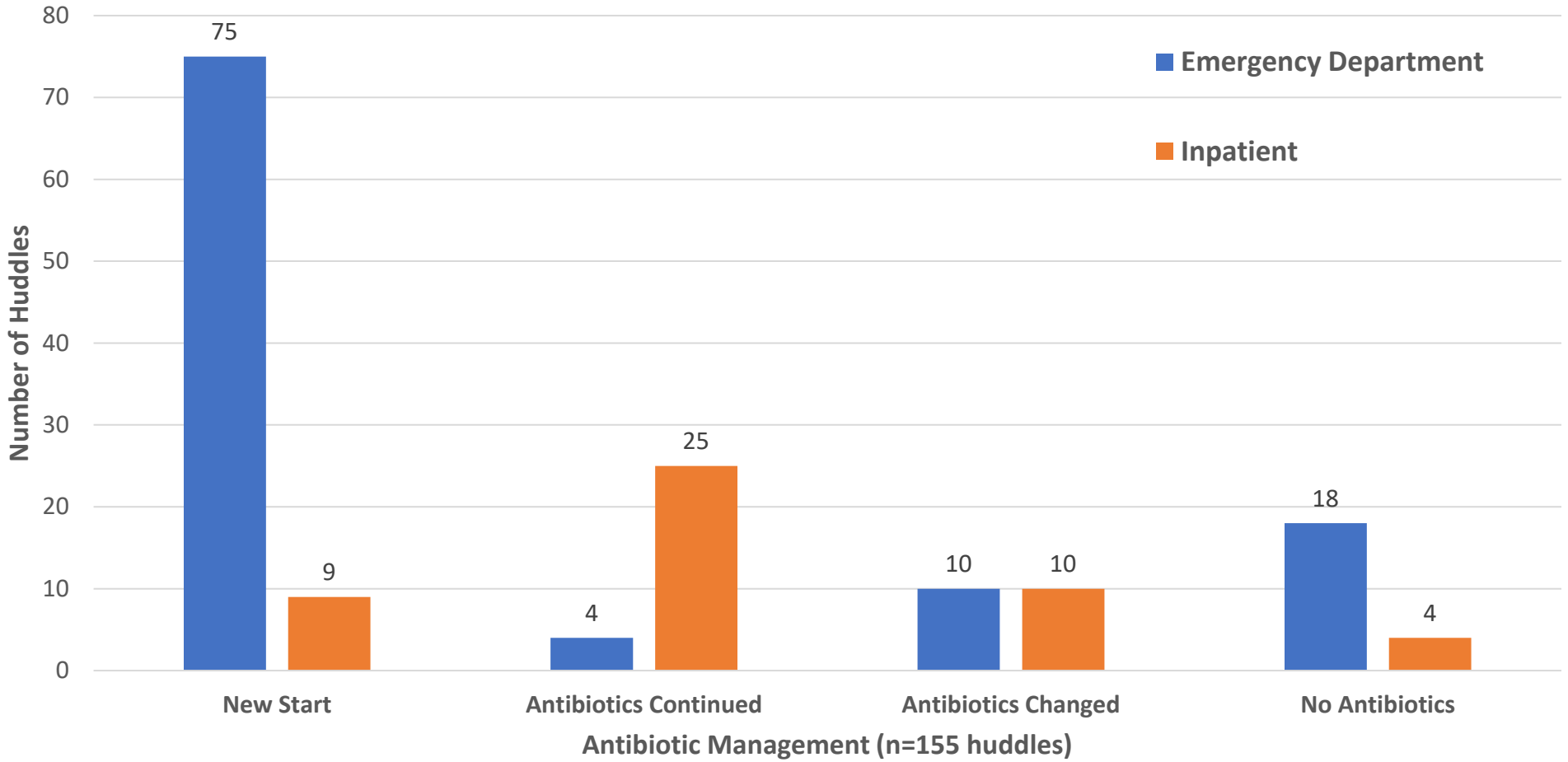
Antibiotic Management Total Cohort

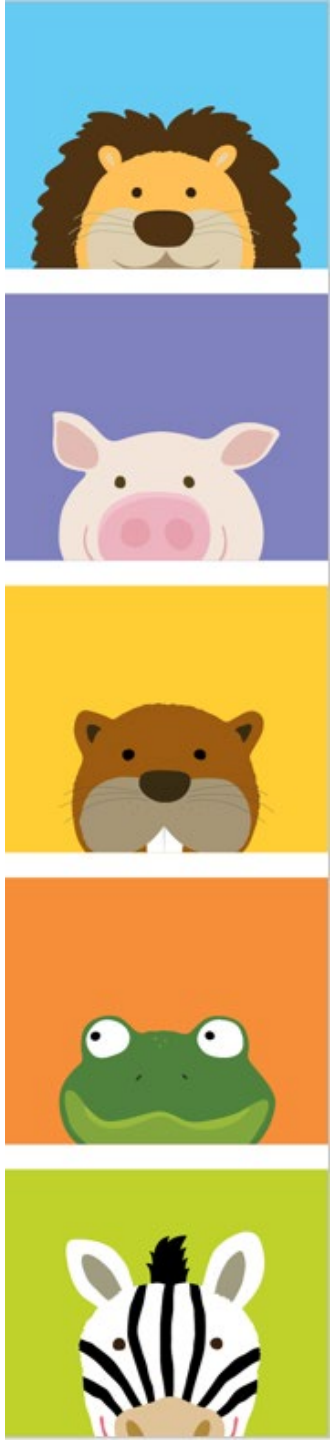
Antibiotic Management	Results (n=155 Huddles)
New Start	84 (54.2%)
Antibiotics Continued*	29 (18.7%)
Antibiotics Changed*	20 (12.9%)
No Antibiotics	22 (14.2%)

*Outpatient course of antibiotics were taken into consideration if antibiotics were continued or changed



Antibiotic Management by Location





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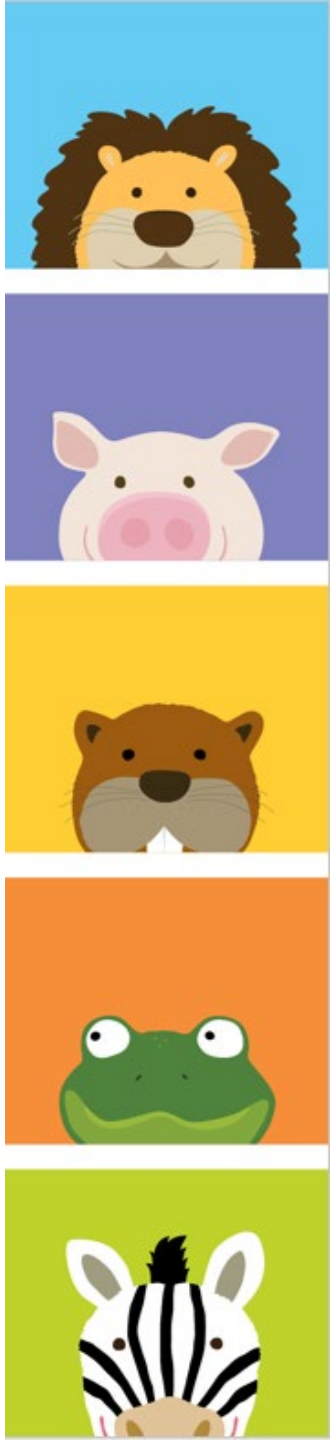
Antibiotic Management by Sepsis Classification

Antibiotic Management	Results
New Start	
○ Sepsis Watch (n=78)	38 (48.7%)
○ Non-Severe Sepsis/Septic Shock/Unknown (n=77)	46 (59.7%)
Antibiotics Continued	
○ Sepsis Watch (n=78)	16 (20.5%)
○ Non-Severe Sepsis/Septic Shock/Unknown (n=77)	13 (16.9%)
Antibiotics Changed	
○ Sepsis Watch (n=78)	5 (6.4%)
○ Non-Severe Sepsis/Septic Shock/Unknown (n=77)	15 (19.5%)
No Antibiotics	
○ Sepsis Watch (n=78)	19 (24.4%)
○ Non-Severe Sepsis/Septic Shock/Unknown (n=77)	3 (3.9%)

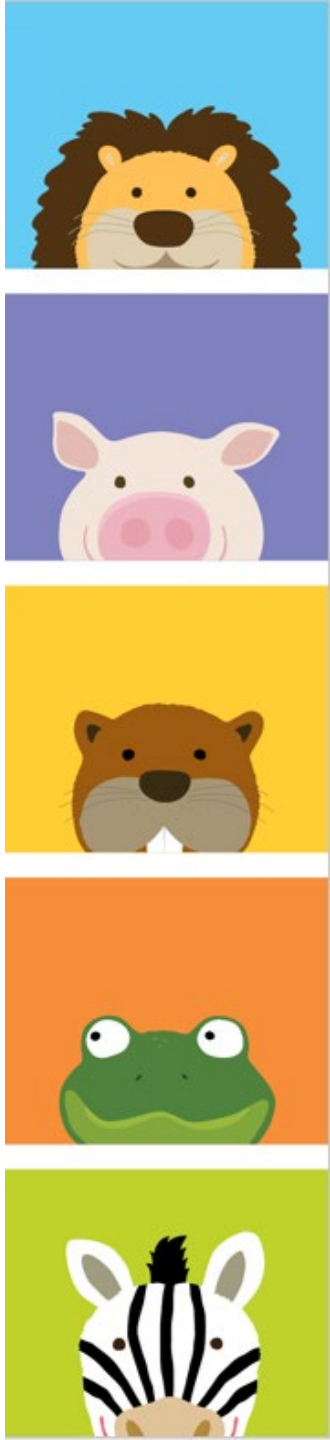


Antibiotic Appropriateness Total Cohort

- Antibiotics were appropriate for 88% of huddles (117/133 huddles*)

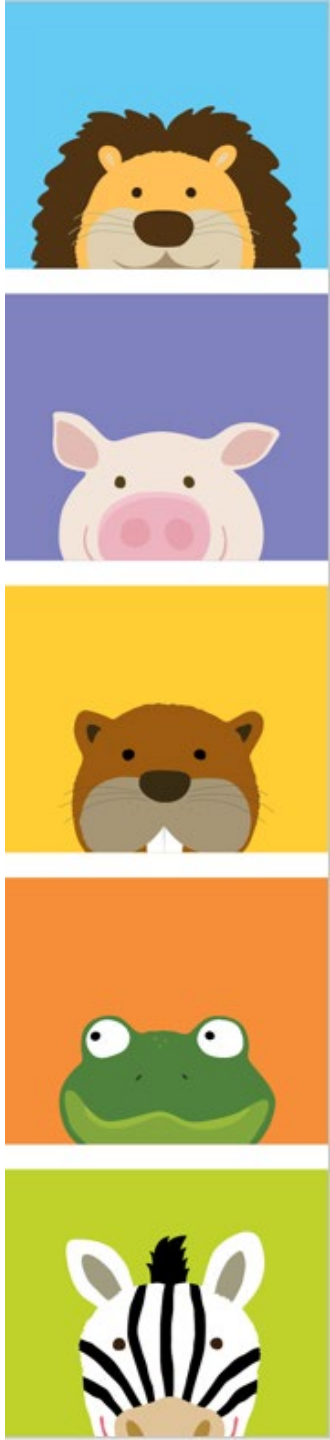
Antibiotic Management	Appropriateness
New Start, n (%) (n=84)	68 (80.9%)
Antibiotics Continued, n (%) (n=29)	29 (100%)
Antibiotics Changed, n (%) (n=20)	20 (100%)

*22 huddles evaluated did not have antibiotics prescribed and were excluded from analysis



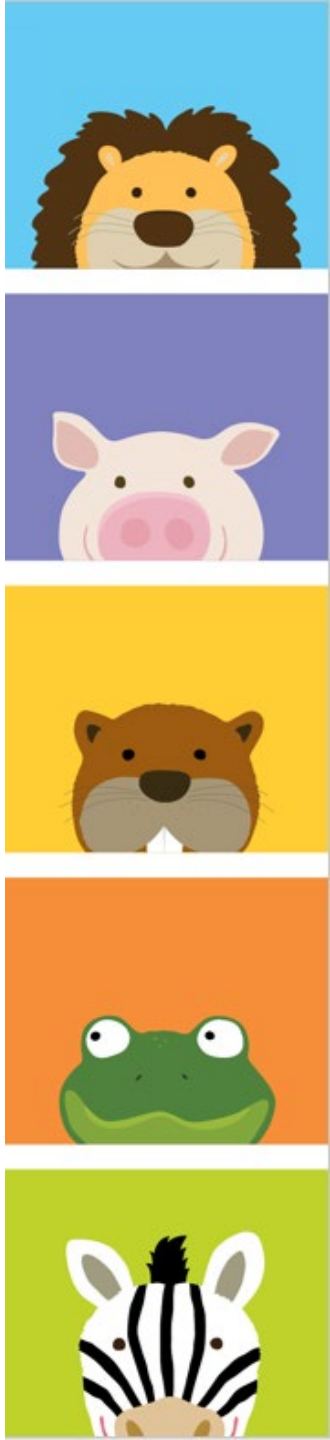
Antibiotic Appropriateness Stratified by Location

Sepsis Stratification	Appropriateness
Sepsis Watch ○ Emergency Department (n=39) ○ Inpatient (n=20)	 29 (74.4%) 20 (100%)
Non-Severe Sepsis/Septic Shock/Unknown ○ Emergency Department (n=50) ○ Inpatient (n=24)	 44 (88%) 24 (100%)



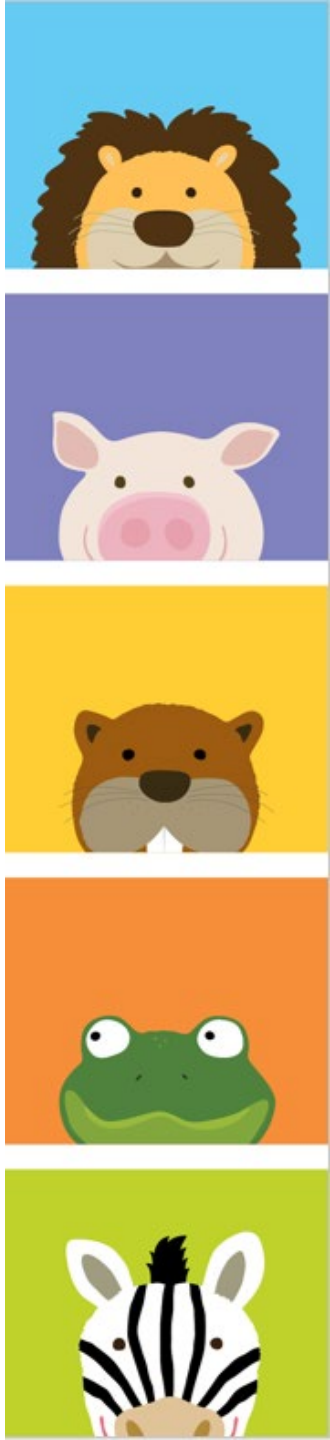
Source of Infection at Huddle

Source of Infection at Huddle	Number of Patients (n=155)
Unknown	48 (31%)
Pneumonia	47 (30.3%)
Intra-Abdominal	14 (9%)
Urinary Tract Infection	12 (7.7%)
Febrile Neutropenia	11 (7.1%)
Meningitis	5 (3.2%)
Bacteremia	3 (1.9%)
Skin/Soft Tissue	3 (1.9%)
No Concern for Infection	2 (1.3%)
Viral Infection	2 (1.3%)
Acute Otitis Media	2 (1.3%)
Other (Bronchiectasis, Dental Abscess, Bone/Joint, Liver Abscess, Acute Chest, Toxic Shock)	6 (3.9%)



Final Source of Infection

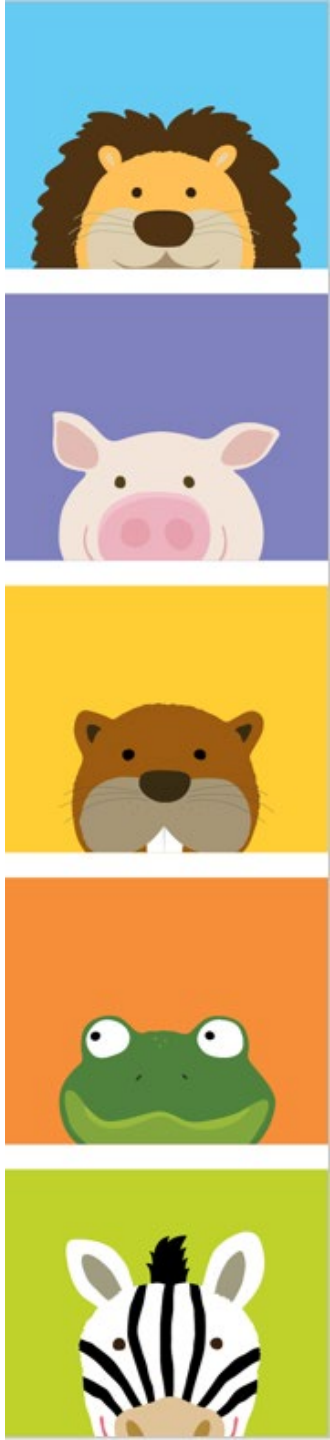
Final Source of Infection	Number of Patients (n=155)
Pneumonia	36 (23.2%)
No Infection Identified	31 (20%)
Confirmed Viral Infection	26 (16.8%)
Bacteremia	18 (11.6%)
Intra-Abdominal	12 (7.7%)
Urinary Tract Infection	8 (5.2%)
Acute Otitis Media	5 (3.2%)
Skin/Soft Tissue	3 (1.9%)
Meningitis	3 (1.9%)
Strep Pharyngitis	2 (1.3%)
Bone/Joint	2 (1.3%)
Unknown	2 (1.3%)
Other (Malaria, Dental Abscess, Bronchiectasis, Sinusitis, Infectious Diarrhea, Liver Abscess, Toxic Shock)	7 (4.5%)



Duration of Antibiotics

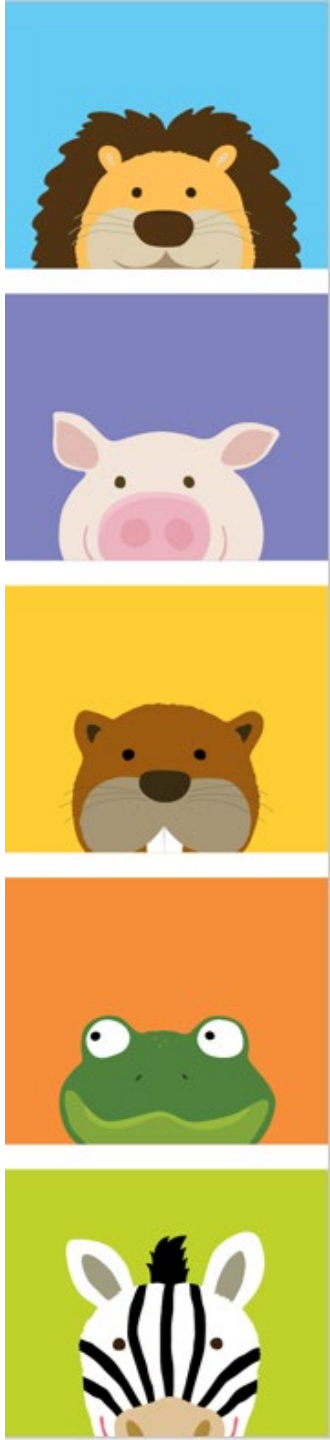
- Duration for patients receiving antibiotics (n=133)
  - Average: 9.7 days

- Duration if no bacterial infection identified (n=57)
  - Average: 2.5 days



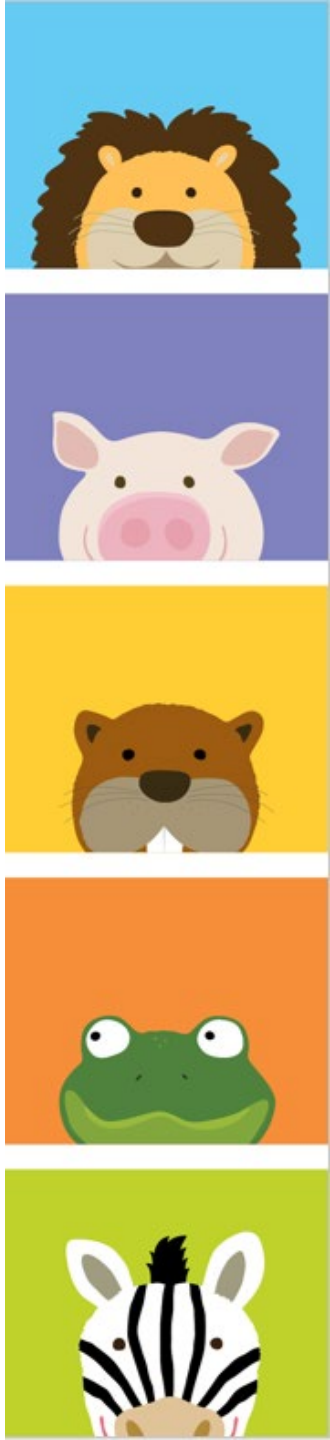
Limitations

- Retrospective chart review
- Inconsistent huddle documentation
  - Missing huddle documentation
  - Mismatch sepsis designation
- Determination of appropriateness
  - Utilized documented physician diagnosis



Conclusion

- 54% of the huddles evaluated resulted in initiation of antibiotics
- 88% of antibiotics deemed appropriate
- No bacterial infection was identified in 37% of encounters
  - Average duration 2.5 days
- 92% of patients had a blood culture obtained
  - 13% were positive



Next Steps

- Reduce duration of empiric treatment for patients where a bacterial infection is not identified
- At completion of project, screening tool changed from manual process to automated in the EMR
- Evaluate opportunities related to diagnostic stewardship