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Characterizing New Invasive Infections in Children's Mercy Extracorporeal Membrane Oxygenation and and Continuous Renal Replacement Therapy Patients

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Background

Extracorporeal Membrane Oxygenation (ECMO)

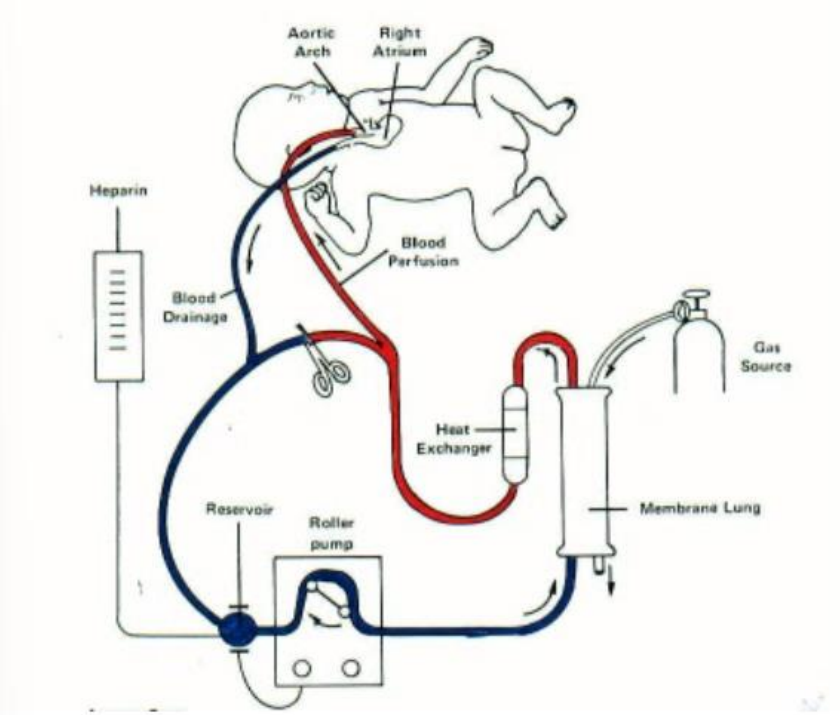
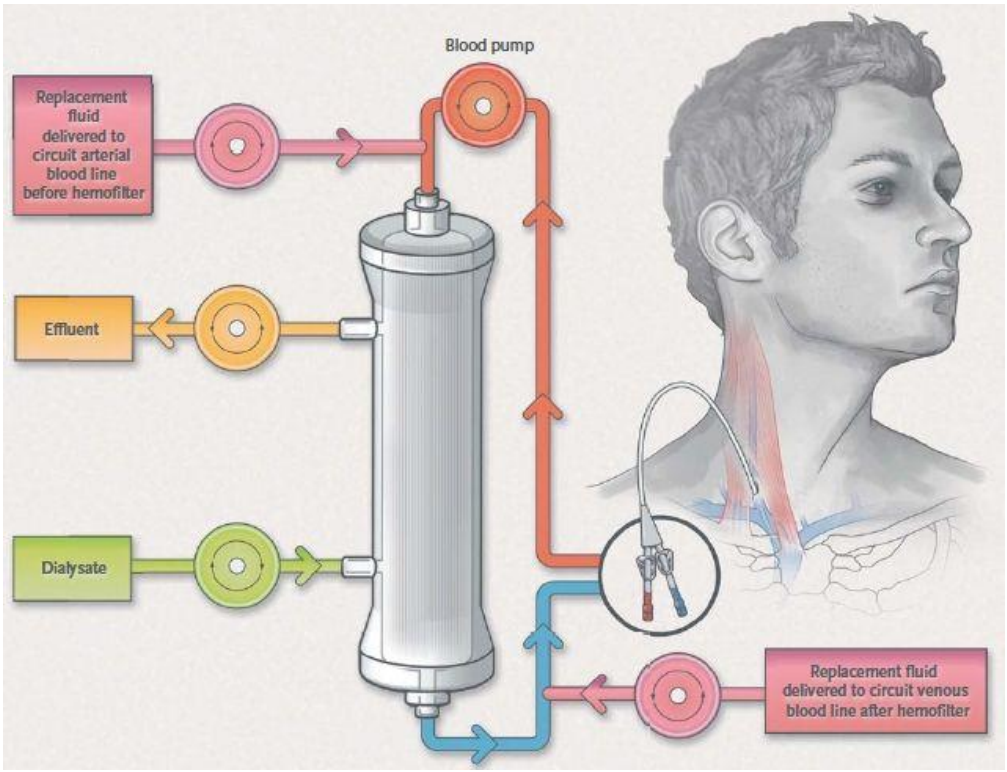


Figure 2: Example of VA ECMO Circuit

Continuous Renal Replacement Therapy (CRRT)



Extracorporeal use itself increases risk of infection

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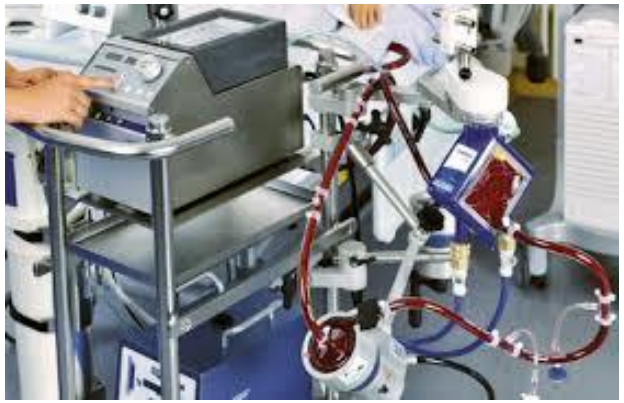
Background

- Temperature regulation occurs while on extracorporeal support
  - The tell-tale infectious sign of fever is lost
    - Intensivists must rely on other clinical and biochemical data, which have variable accuracy, to trigger suspicion of infection



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Background Literature Summary

- Reported rates of new serious bacterial infections during pediatric ECMO runs are 3.5-42%[1] with a BSI rate of 19-48%.[1,5]
  - Incidence of new infections during pediatric CRRT runs is relatively unknown[3]
- On ECMO, known infectious biomarkers such as C reactive protein, procalcitonin[1,3,4,5] and WBC[4,5] have variable specificity for infection detection
  - On CRRT, there are no reliable infectious biomarkers[6]
- There is no standardization of when to draw cultures, start or stop antibiotics[2]
  - When polled hemodynamic instability alone(71%) or with rising inflammatory markers (78%) were most common ECMO intensivists triggers to suspect an infection

1) MacLaren et Al 2020
2) Farrell et Al 2019
3) Santiago et Al 2017
4) Tan et Al 2018
5) Doo et All 2002
6) Honroe et Al 2020

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Research Questions

- What is the new invasive infection rate after 72 hours on extracorporeal support?
  - Hypothesis: BSIs will be the most encountered invasive bacterial infection and will most commonly occur after seven days on extracorporeal support
- Are changes in extracorporeal circuit anticoagulation needs a reliable marker of a new invasive infection?
  - Hypothesis: A 10% change in extracorporeal circuit anticoagulation needs will be indicative of a new infection

Study Design

Inclusion Criteria	Exclusion Criteria
<18 years old	Preexisting liver failure
Admitted to neonatal, cardiac or pediatric intensive care unit and required ECMO or CRRT	Preexisting coagulopathy
	Positive culture -<72 hours from initiation of extracorporeal support -<72 hours prior to initiation of support that remained positive
	Clinically insignificant infection*

- Data collected from 2017-2023
- Data including demographics, laboratory, and therapy data, were collected into Redcap©.

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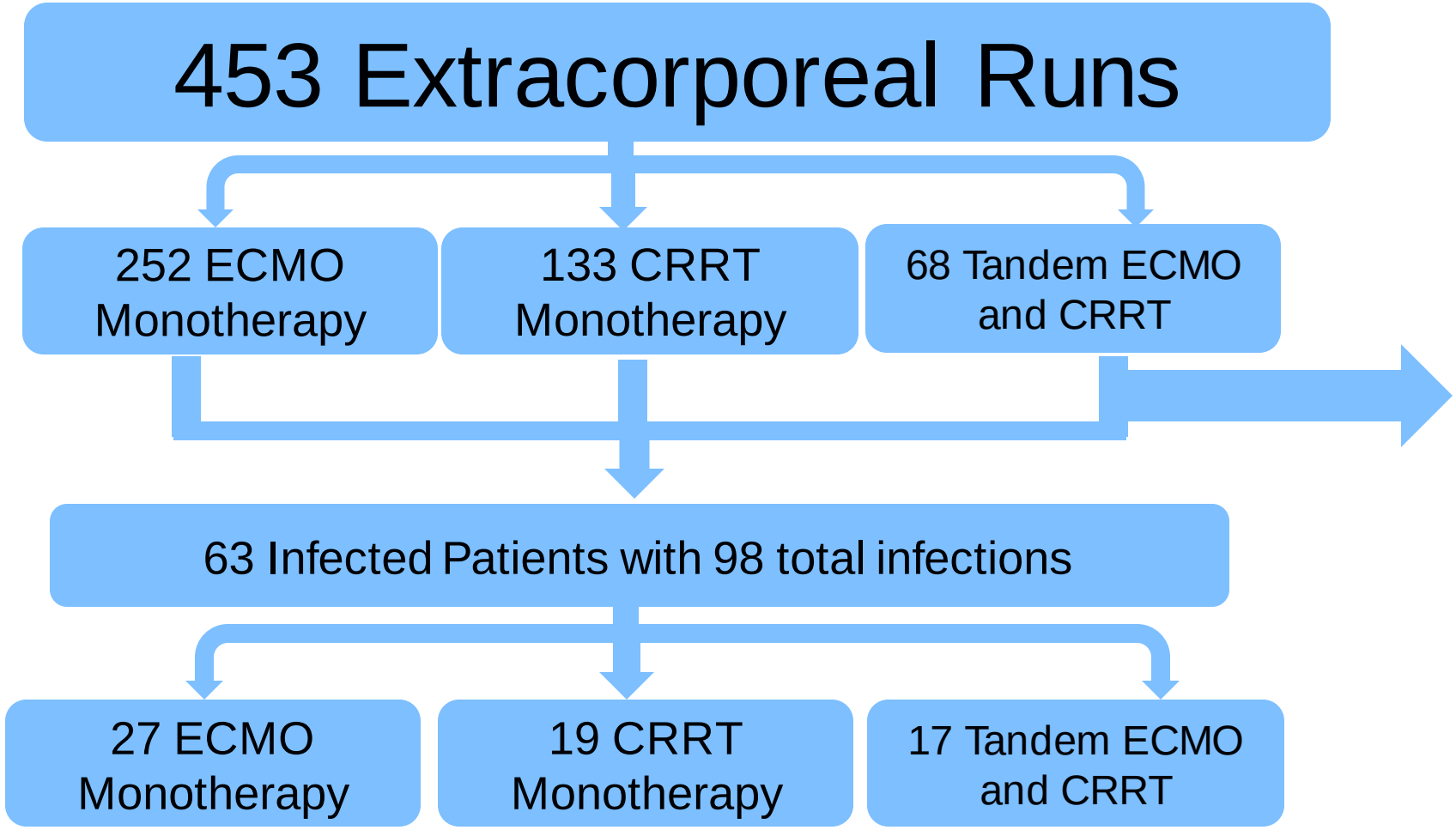
Between 2017-2023



390 Excluded

- 306 without positive cultures
- 44 positive prior to extracorporeal initiation or within 72 hours of initiation
- 40 clinically insignificant cultures

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Demographics

Demographic	Number (%)
Age: Median	
0-2 years	38 (63%)
2-12 years	16 (25.4%)
12-18 years	9 (14.3)
Race	
American Indian of Alaskan Native	2 (3.2%)
Asian	1 (1.6%)
Asia/Indian Pacific Islander	0 (0%)
Black of African American	7 (11.1%)
Hispanic or Latino	7 (11.1%)
Native Hawaiian	1 (1.6%)
White	43 (73%)
Unknown	1 (1.6%)
Gender	
Female	28 (44.4%)
Technology Dependence	9 (14.3%)
G or GJ Tube	6 (9.5%)
Tracheostomy +/- Ventilator	2 (3.2%)
VAD	2 (3.2%)
Immunosuppressed	12 (19%)
Mortality	28 (44.4%)

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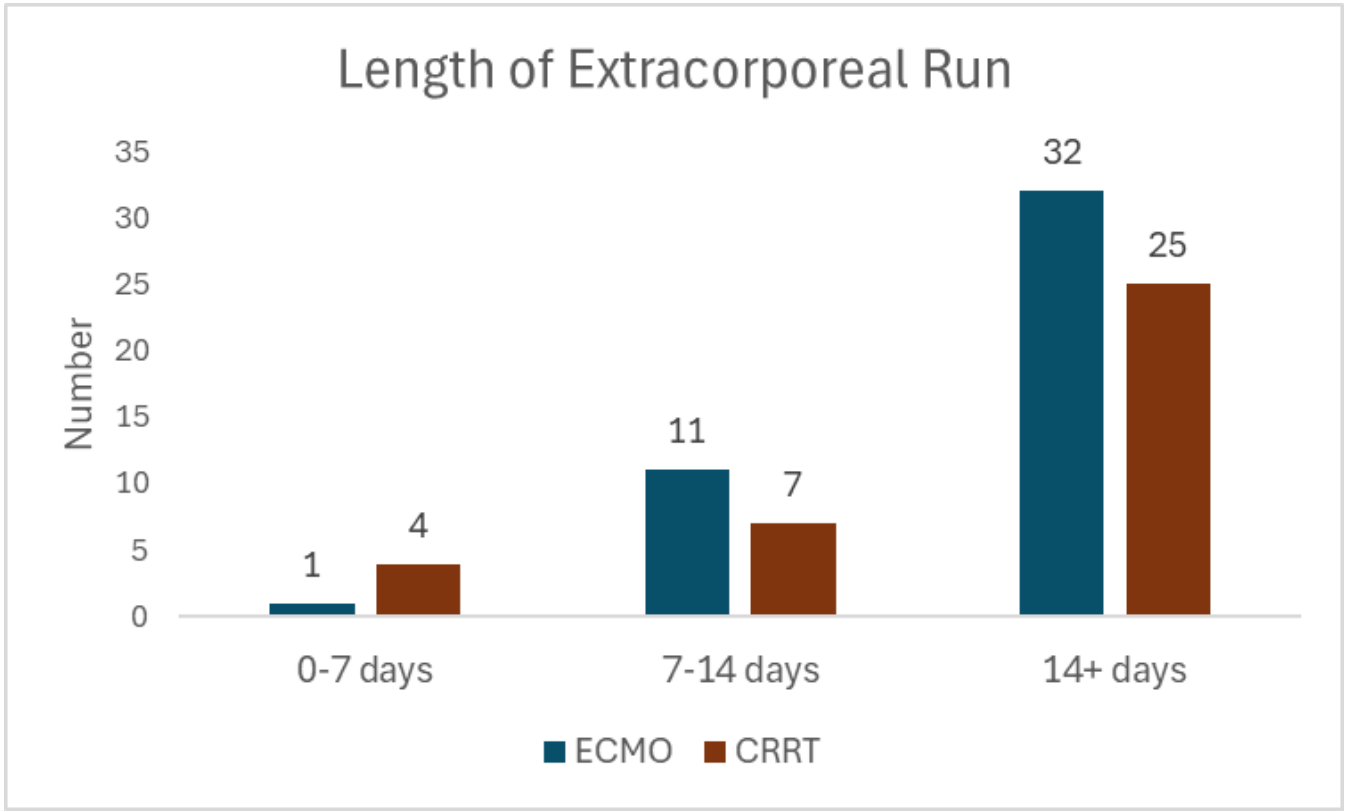
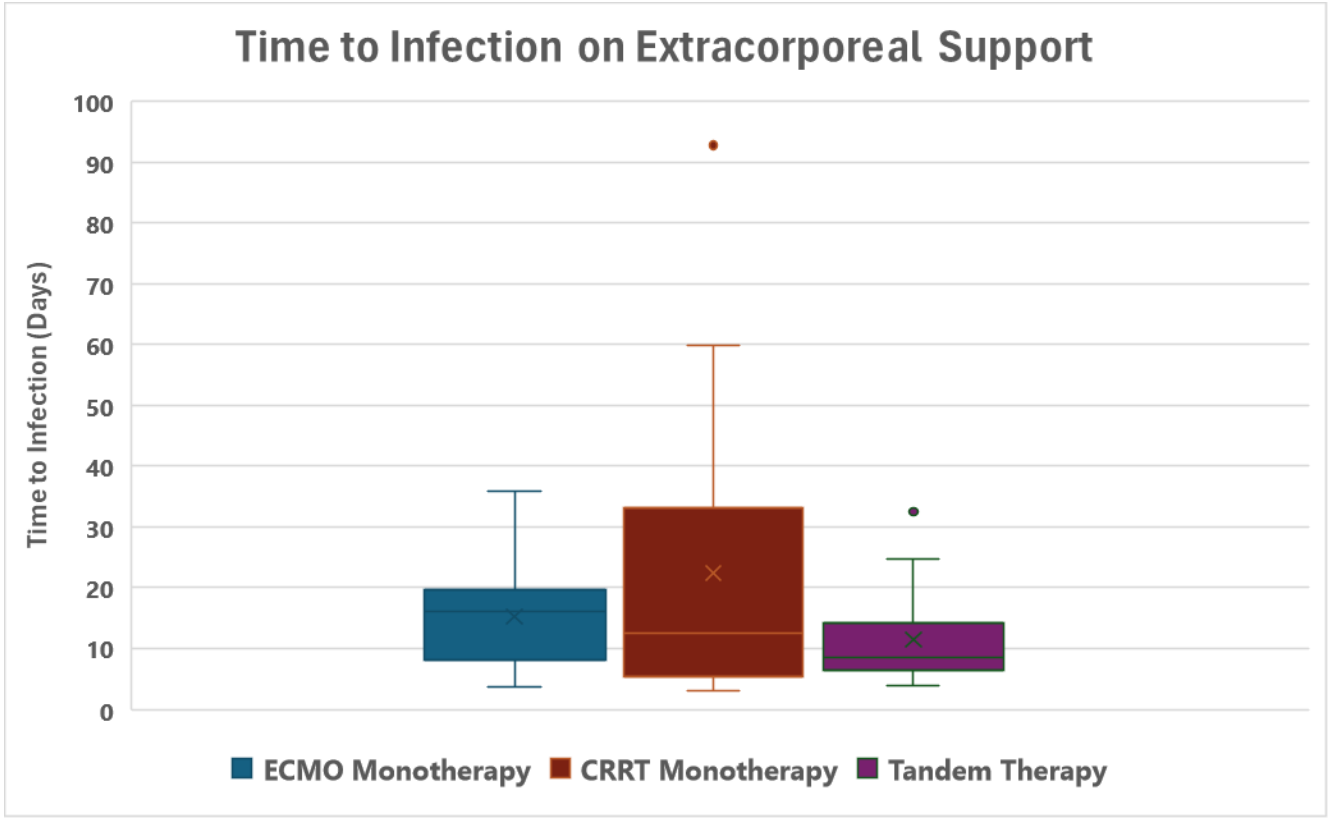
Extracorporeal Support

ECMO Monotherapy	Number (%)
Patients	27 (35.4%)
Median Run Time	23.65 days
CRRT Monotherapy	**Number (%)**
Patients	19 (30.6%)
Median Run Time	28.71 days
Tandem Therapy	**Number (%)**
Patients	17 (27.4%)
Median Run Time ECMO CRRT	 14.73 days 18.54 days



Time to Infection



- Median time to infection
  - ECMO Monotherapy: 16.19 days
  - CRRT Monotherapy: 12.62 days
  - Tandem therapy: 8.45 days

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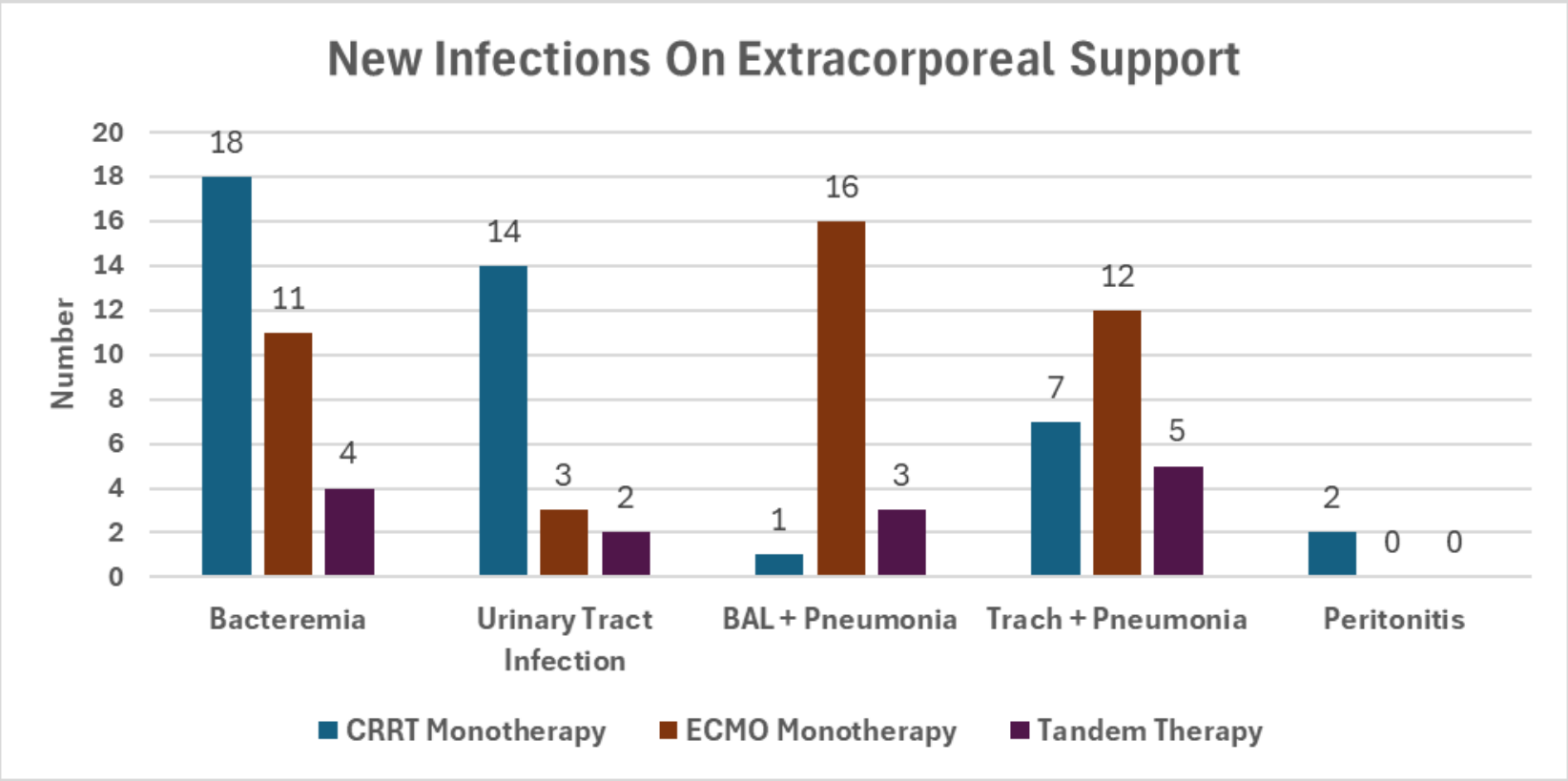
Infection Data



- 98 total infections
  - 40 (41%) on ECMO
  - 44 (45%) on CRRT
  - 14 (14%) on both
- Infection rate
  - 13.8% of all ECMO runs
    - BSI Rate: 4.7%
  - 17.9% of all CRRT runs
    - BSI rate: 10.9%

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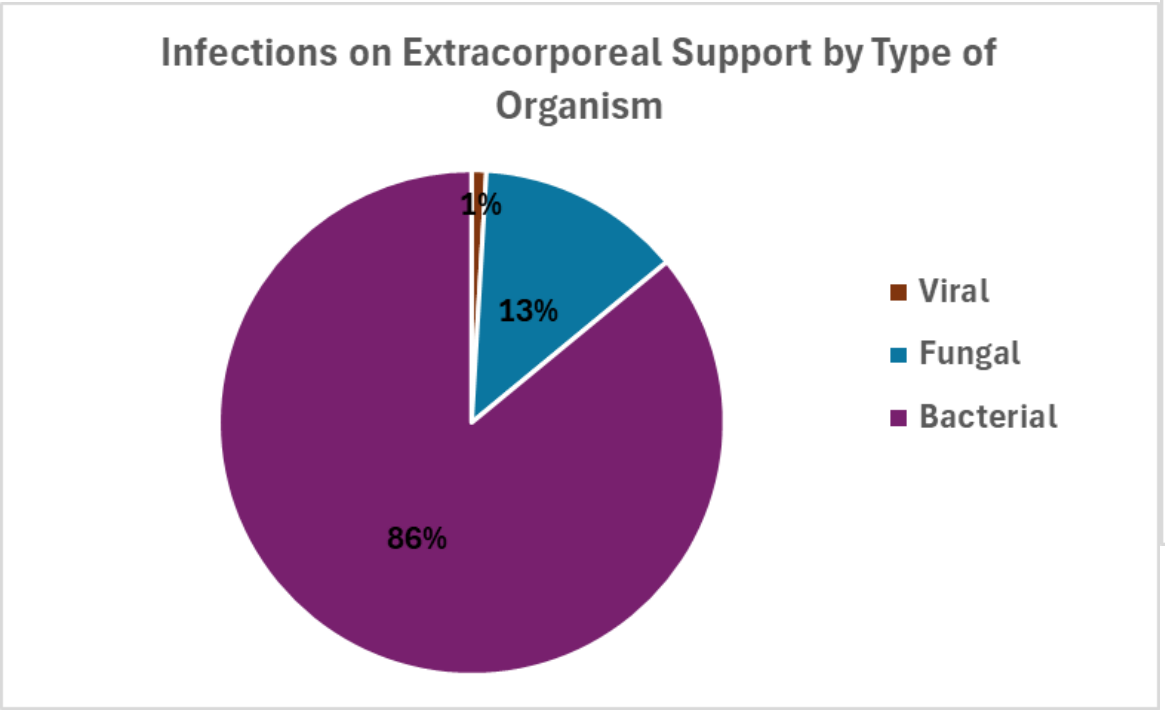
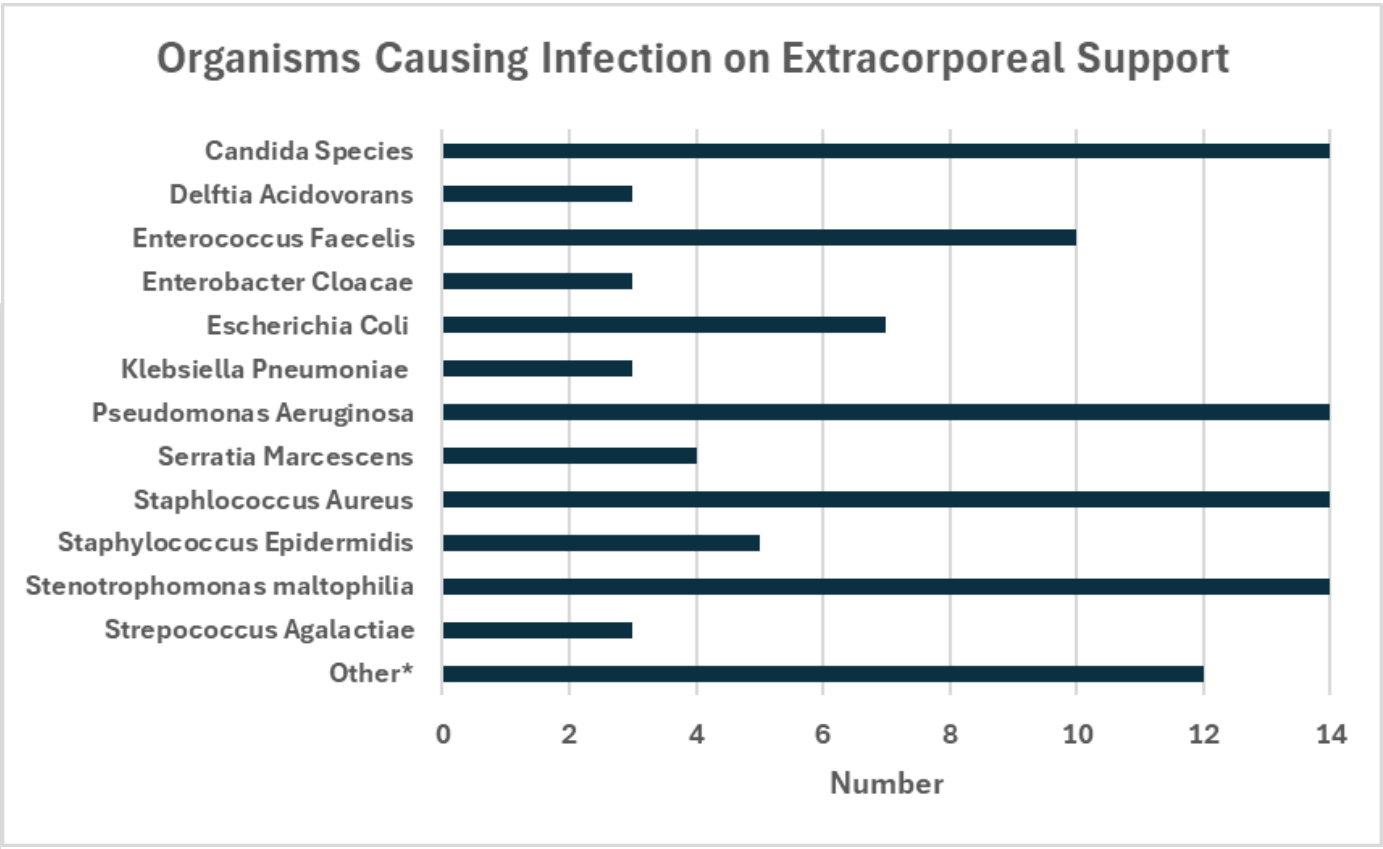
Organism Data





- E. Faecelis and Staph aureus were most common blood stream infection
- Candida species were most common urinary tract infection
- Staph aureus and Stenotrophomonas were most common lower respiratory tract infections

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Discussion

- CMH's BSI rate (4.7%) for patients on ECMO is on the lower end of currently reported literature
- The BSI rate on CRRT (10.9%) is higher than that of ECMO
- BSIs were the most reported infection at 33.6%
  - Respiratory infections were more common on ECMO
  - Blood stream infections were more common on CRRT
- Infections most commonly occur at >12 days for monotherapy runs but at only >8 days for tandem runs despite most extracorporeal runs being longer than 14 days
- Although bacterial infections were by far the more common infections this is the first known report also characterizing invasive fungal and viral infections while on extracorporeal support

Future Directions

- Partner with Cincinnati Children's, Dell Children's Medical Center and Texas Children's hospitals and collect data of their infection patients on ECMO and CRRT to compare with CMH data
- Collect a cohort of control patients from CMH who did not experience an infection while on extracorporeal support to compare to the CMH infected cohort
  - This will be done for CMH patients only

Future Directions

- Assess if extracorporeal anticoagulation circuit needs for commonly used anticoagulants can be used as markers to diagnose a new infection by
  - Percent dosage change: either increase or decrease
  - Absolute number of dosage changes
- Investigate if commonly used markers of infection reliable markers to diagnose a new infection on extracorporeal support
- Assess if increase in transfusion requirements is a marker to diagnose a new infection

SOC Members

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- Josh Herigon, MD
  - *Medical Director, Antimicrobial Stewardship Program; Assistant Professor of Pediatrics, University of Missouri-Kansas City School of Medicine; Education Assistant Professor of Pediatrics, University of Kansas School of Medicine*
- Jenna Miller, MD
  - *Medical Director, Extracorporeal Membrane Oxygenation (ECMO) Services; Program Director, Pediatric Critical Care Medicine Fellowship; Associate Professor of Pediatrics, University of Missouri-Kansas City School of Medicine*

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Thank you!