Positive Cultures and Negative Imaging: Challenges in Diagnosing Pneumonia in a Pediatric Cardiac ICU

Casey L. Fitzgerald, APRN, CPNP-AC[1], Sandeep Arya, MBBS[1], Marivee Borges, MD[1], Lucy Sommerdorf, BSN, RN, CIC[2], and Annie Thomas, RN, BSN[2]
[1]Texas Center for Pediatric and Congenital Heart Disease, UT Health Austin & Dell Children's Medical Center, Austin, TX
[2]Dell Children's Medical Center, Austin, TX

Introduction

Ventilator-associated pneumonia (VAP) is a significant cause of morbidity in pediatric cardiac intensive care units (CCU), where children often require prolonged mechanical ventilation following complex heart surgery. Unique vulnerabilities—including immature immune systems, altered cardiopulmonary physiology, and frequent use of invasive devices—place these patients at increased risk. Management of VAP requires timely initiation of empiric broad-spectrum antibiotics guided by likely pathogens and local resistance patterns, with prompt de-escalation based on culture results. However, respiratory cultures may yield false-positive results due to airway colonization rather than true infection, which can lead to unnecessary antibiotic exposure. Frequent and prolonged antibiotic exposure in this population increases the risk of promoting antibiotic-resistant organisms, highlighting the importance of careful clinical correlation and antimicrobial stewardship to balance effective treatment with the prevention of resistance.

Research Goal

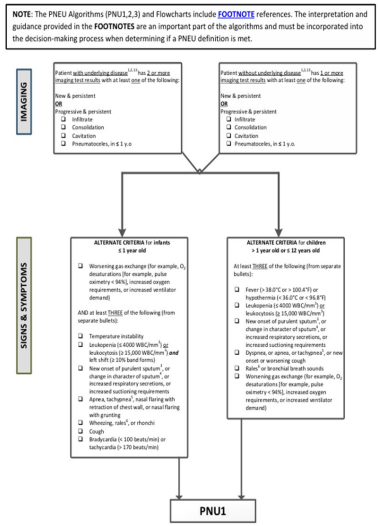
In this study, we aimed to capture the incidence of positive respiratory cultures and subsequently delineate true infections from false-positive results based on Centers for Disease Control and Prevention / National Healthcare Safety Network (CDC/NHSN) criteria for pneumonia events—including ventilator-associated pneumonia (VAP) and non–ventilator-associated pneumonia (PNEU)—as defined in the January 2026 NHSN surveillance protocol. We also sought to determine whether the prevalence of true VAP/PNEU differed between patients with cyanotic versus non-cyanotic congenital heart lesions.

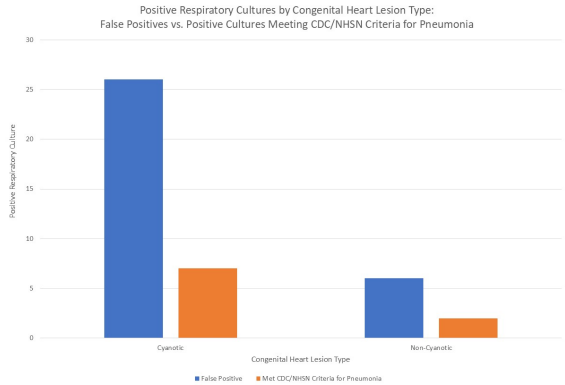
Methods

The Dell Children's Medical Center database was used to assess the incidence of positive respiratory cultures in the CCU from April through December 2025. Respiratory culture data were reviewed through the electronic medical record (EMR) and adjudicated by a multidisciplinary workgroup comprising of CCU clinicians, respiratory therapists, and quality improvement and patient safety specialists. Using the Centers for Disease Control and Prevention/National Healthcare Safety Network (CDC/NHSN) criteria for pneumonia events—including ventilator-associated pneumonia (VAP) and non–ventilator-associated pneumonia (PNEU)—we classified culture results as representing true infection or false-positive findings. Additionally, we assessed the prevalence of confirmed VAP/PNEU among patients with cyanotic versus non-cyanotic congenital heart lesion to evaluate potential differences in risk between lesion types.

Figures and Results

Figure 2: Pneumonia Flow Diagram, Alternative Criteria for Infants and Children





Among the 112 respiratory cultures obtained in the Cardiac Care Unit (CCU) between April and December 2025, 41 (36.6%) demonstrated bacterial growth. All patients were started on empiric antibiotics for 48 hours, and those with culture-positive results were subsequently managed with targeted antimicrobial therapy in accordance with prevailing clinical practices. However, application of standardized surveillance definitions revealed that only 9 of the 41 positive cultures (22.0%), corresponding to 8.0% of all respiratory cultures obtained, fulfilled Centers for Disease Control and Prevention / National Healthcare Safety Network (CDC/NHSN) criteria for a definitive pneumonia event, highlighting a substantial discrepancy between microbiological positivity and clinically adjudicated infection.

Among these 9 confirmed pneumonia cases, 8 patients (88.9%) had undergone, or were maintained on mechanical ventilation within the 24-hour period preceding culture acquisition, suggesting a strong temporal association with ventilator exposure and raising concern for ventilator-associated pneumonia (VAP) as a predominant mechanism. Additionally, 7 patients (77.8%) had a documented history of cyanotic congenital heart disease, indicating that this underlying cardiopulmonary pathophysiology may represent a significant predisposing factor for the development of lower respiratory tract infections in this cohort. Collectively, these findings underscore the importance of integrating microbiological data with standardized clinical criteria to improve diagnostic specificity and to better characterize risk factors associated with nosocomial pneumonia in critically ill cardiac patients.

Conclusion

In this study, positive respiratory cultures were common, yet the majority did not meet CDC/NHSN criteria for pneumonia, highlighting a substantial proportion of false-positive results, likely reflecting airway colonization rather than true infection. True pneumonia events were predominantly associated with recent mechanical ventilation and were more frequent in patients with cyanotic heart lesions, suggesting increased vulnerability in this subgroup. These findings underscore the importance of careful interpretation of respiratory cultures, judicious antibiotic use, and adherence to standardized surveillance definitions to reduce unnecessary antibiotic exposure and mitigate the risk of antimicrobial resistance in pediatric cardiac critical care populations.

Future QI Project

A proposed future project will focus on the implementation of the BrighT STAR Respiratory Collaborative (Testing STewardship for Antibiotic Reduction) respiratory culture algorithm to evaluate its impact on respiratory culture utilization within a comparable time frame, in alignment with published expert consensus recommendations (BrighT STAR Respiratory Collaborative, 2024). The study will aim to determine whether adoption of this diagnostic stewardship approach reduces unnecessary culture acquisition while increasing the proportion of positive cultures that meet Centers for Disease Control and Prevention / National Healthcare Safety Network (CDC/NHSN) criteria for pneumonia events, thereby improving discrimination between true infections and false-positive or clinically insignificant results.

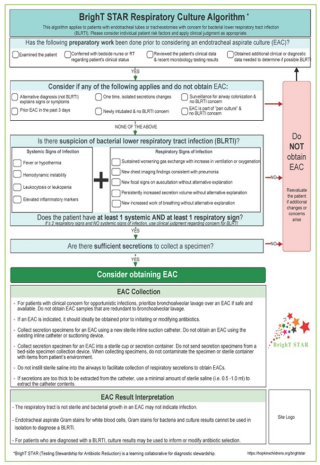


Figure 1. BrighT STAR (Testing STewardship for Antibiotic Reduction) respiratory culture algorithm. BLRTI = bacterial lower respiratory tract infection, EAC = endotracheal aspirate culture.

References

BrighT STAR Respiratory Collaborative. (2024). Diagnostic stewardship of endotracheal aspirate cultures in hospitalized children with artificial airways: Expert consensus statements from the BrighT STAR (Testing STewardship for Antibiotic Reduction) Respiratory Collaborative. *Pediatric Critical Care Medicine*. https://doi.org/10.1097/PCC.0000000000003695

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