Follow-up Respiratory Cultures in Suspected Ventilator-Associated Pneumonia: An Opportunity for Diagnostic Stewardship

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Introduction

Antibiotic overuse is an increasingly recognized problem in the intensive care units (ICUs). A recent multinational point-prevalence study of 1150 ICUs determined that 70% of patients surveyed were receiving antibiotics; only 54% of these patients had suspected or proven infection and only 35% had positive microbiologic cultures supporting a definitive diagnosis of infection. Excess antibiotic use catalyzes the acquisition and spread of multidrug-resistant organisms (MDROs). Antibiotic overuse is associated with adverse patient outcomes such as excess morbidity, mortality, and healthcare expenses. In the ICU, treatment for suspected respiratory infection, specifically, ventilator-associated pneumonia (VAP), accounts for 50-70% of antibiotic use. Most efforts to curb inappropriate VAP-directed antibiotic use have focused on therapeutic processes such as antibiotic discontinuation or de-escalation strategies for patients with an established VAP diagnoses. However, very little efforts have addressed the diagnostic process. For example, in the ICU assuming a VAP prevalence of 10% among mechanically-ventilated patients, those with fever but without new radiographic infiltrates, alterations in gas exchange or purulent sputum have a pretest probability of VAP prior to respiratory cultures (RC) of 2.6%. A positive RC in this context increases the posttest probability of VAP to only 3.7%, rendering the test ineffectual. Despite this, RCs are often ordered as part of a “pan-culture” workup for fever or leukocytosis in mechanically-ventilated patients who are otherwise stable. By assessing the prevalence and indications of RC in our ICU, we will be able to show why an intervention is necessary and how this intervention can be tailored to fit the needs of our ICU providers.

Methods and Materials

The diagnostic stewardship interventions occur at discrete time points along the diagnostic testing pathway: 1]the pre-analytic phase-test are ordered 2]the analytic phase-diagnostic tests are collected and laboratory tests are performed 3]the post-analytic phase-test results are communicated to frontline clinical providers. In this study, our goal is to analyze the pre-analytic phase. Retrospective descriptive cohort study of adult patients in Michigan Medicine ICUs requiring invasive mechanical ventilation in 2019 who had repeat respiratory cultures (RCx) performed within 72 hours after an index respiratory culture were collected. Relevant patient demographics, comorbidities, culture indications and consequent antimicrobial modifications based on RCx were captured using IRB approved web-capturing database, Redcap. Subsequent statistical analysis using SAS were performed.

Results

Of 2340 total respiratory cultures performed, 286 (12%) were RCx. Patient characteristics and indications for culture collection are shown in Figures 1 and 2, respectively. Only 12 patients (4%) had antimicrobial agents modified based on growth of a pathogenic organism from a RCx not covered by the prior antimicrobial regimen. In cases where RCx grew an identical organism with an identical susceptibility profile to the initial respiratory culture, existing antibiotic treatment durations were extended for microbiologic positivity in 12% of cases. Notably, 94 patients (33%) had RCx performed for persistent fevers or leukocytosis, without corresponding changes in ventilator requirements, changes in endotracheal secretions or worsening appearance on chest imaging.

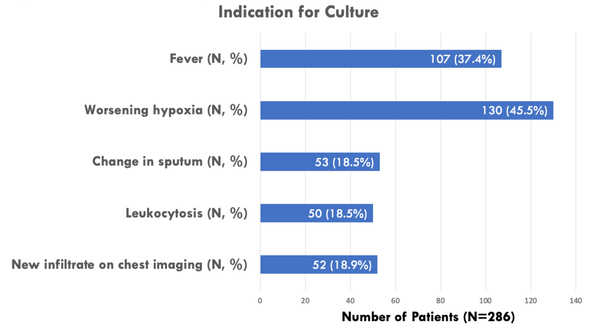
Results Continuation

Figure 1. Selected characteristics of study cohort.

Variable	Patients with repeat respiratory culture within 72 hours (N=286)
Demographics	
Age at time of culture (mean, SD)	57.8 (14.7)
Gender assigned at birth (male, %)	201 (70.3%)
BMI (mean, SD)	29.1 (8.1)
Race (white, %)	231 (80.7%)
Current or former smoker (N, %)	155 (54.2%)
Comorbidities	
Immunocompromised (N,%)	115 (40.2%)
Structural lung disease (N, %)	67 (23.4%)
CHF (N, %)	64 (22. 3%)
CVA hx (N, %)	48 (16.8%)
CKD (N, %)	76 (26.6%)
Cirrhosis (N, %)	15 (5.2%)
Diabetes Mellitus (N, %)	102 (35.7%)
Chronic Oxygen requirement? (N, %)	52 (18.2%)
Tracheostomy at time of culture (N,%)	54 (18.9%)

Immunocompromised=Human Immunodeficiency Virus, hematopoietic stem cell transplantation, solid organ transplantation, long-term use of corticosteroids, biologic therapies, calcineurin inhibitors. CHF=congestive heart failure. CVA= history of cerebrovascular accident. CKD=chronic kidney disease.

Figure 2. Indications for repeat respiratory cultures



Note that percentages do not add to 100% as some patients had multiple indications for repeat respiratory culture performance.

Discussion/Conclusion

RCx performed within 72 hours of an initial respiratory culture in mechanically-ventilated patients was both common and low-yield. RCx not uncommonly precipitated unnecessary prolongation in antimicrobial treatment durations, and nearly one-third of patients had RCx obtained for persistent fevers or leukocytosis without other signs of VAP treatment failure, a suspect indication for culture collection given that the median time to clinical improvement in VAP clinical trials is 4-5 days. Limiting repeat respiratory cultures in ICU patients represents a potentially valuable opportunity for diagnostic stewardship. Overall, diagnostic stewardship interventions that address the indiscriminate use of respiratory cultures need to be redefine to improve their yield in clinical care and antibiotic usage in ICUs.

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Acknowledgments:
-Dr. Albin Owen for guidance and teaching
-University of Michigan Office of Medical Education for funding and support