Utility of Respiratory Specimen Gram Stain for Predicting Final Culture Results in Patients with Clinically Diagnosed Pneumonia

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Abstract

INTRODUCTION: IDSA guidelines recommend obtaining a respiratory tract specimen for Gram stain and culture in patients with suspected pneumonia.[1] Conflicting evidence has led to questions about the value of the Gram stain for identifying a causative pathogen.[2-4] The purpose of this study was to assess the utility of the Gram stain for predicting final culture results in patients with pneumonia.

METHODS: This retrospective chart review evaluated hospitalized adults with clinically diagnosed pneumonia who had a respiratory specimen submitted for Gram stain and culture. The primary outcome was the correlation between Gram stain and final culture. Secondary outcomes included influence of antibiotic exposure prior to specimen collection, as well as the correlation rates based on the semi-quantitative count of bacteria on Gram stain.

RESULTS: A total of 269 acceptable specimens were assessed. Of the 72 specimens with an organism identified on Gram stain, 41 subsequently grew a potential pathogen in culture, resulting in a positive predictive value (PPV) of 56.9%. Of 197 specimens with no bacteria on the Gram stain, 154 grew either normal flora or nothing on final culture. This equated to a negative predictive value (NPV) of 76.7%. The NPV of Gram stain was decreased if antibiotics were administered for > 24 hours prior to specimen collection. The PPV increased linearly with higher semi-quantitative counts on Gram stain.

CONCLUSION: The respiratory specimen Gram stain demonstrates limited ability to predict bacterial isolation in final culture. Empiric antibiotic regimens should be adjusted cautiously based solely on Gram stain results.

Objective

To evaluate the utility of respiratory specimen Gram stain for predicting final culture results in patients with pneumonia

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Methods

Retrospective chart review

- All patients with a respiratory specimen acceptable for culture (Containing < 10 squamous epithelial cells per low power field)
- Study time period: January 1 – September 30, 2018

Inclusion Criteria

- Age ≥ 18 years old
- Inpatient admission
- Clinical diagnosis of pneumonia per CDC surveillance definition

Outcomes

Primary:

- Correlation of respiratory specimen Gram stain with final culture results

Secondary:

- Correlation rates within each specimen collection method
- Influence of antibiotics on correlation rates
- Correlation rates within each semi-quantitative Gram stain group
- Discordance rate between a positive gram stain and a positive culture

Statistical analyses

- Positive predictive value (PPV)
- Negative predictive value (NPV)
- Sensitivity
- Specificity

CDC Surveillance Definition of Pneumonia[5]

Radiology	Laboratory/Signs/Symptoms
At least 1 of the following: • New or progressive infiltrate • Consolidation • Cavitation	At least 1 of the following: • Fever (>100.4°F) • Leukopenia (<4, WBC/mm^3) or leukocytosis (>12K WBC/mm^3) At least 2 of the following: • Purulent sputum/change in character of sputum/increased secretions or suctioning requirements • New or worsening cough, dyspnea, or tachypnea • Rales or bronchial breath sounds • Worsening gas exchange

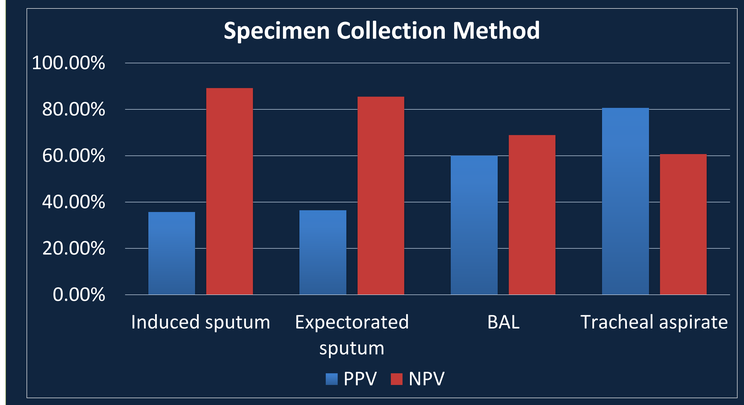
Results

Baseline Characteristics

Mean age	64.5 years
Male	150 (56%)
Antibiotics given for > 24 hours prior to specimen	89 (33.1%)
Specimen Collection Method	
Expectorated sputum	105 (39%)
Tracheal aspirate	92 (34.2%)
Induced sputum	51 (19%)
Bronchoalveolar lavage	21 (7.8%)

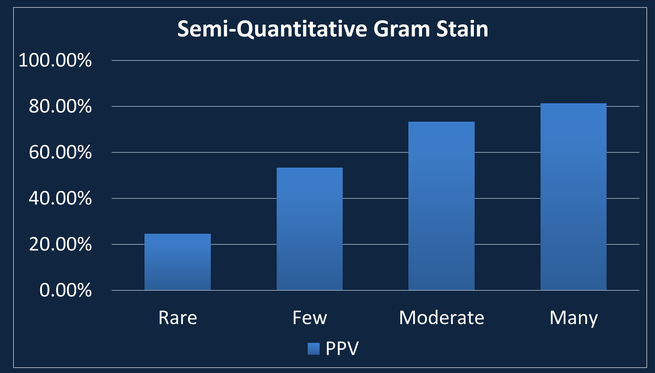
Primary Outcome

Positive Predictive Value	Negative Predictive Value
The probability of a bacteria growing in final culture when the Gram stain reveals a morphology	The probability of the final culture being negative when the Gram stain fails to reveal a morphology
56.9% (41/72)	78.2% (154/197)
Sensitivity	**Specificity**
The probability of the Gram stain being positive when the final culture is positive	The probability of the Gram stain being negative when the final culture failed to isolate a pathogen
47.8% (41/86)	84.2% (154/183)



Antibiotic duration prior to collection	PPV	NPV
Less than 24 hours	29/50 (58%)	105/130 (80.8%)
Greater than 24 hours	12/22 (54.5%)	47/67 (70.1%)

Results (cont.)



Study Critique

Limitations

- Positive cultures could represent contaminants or colonization
- Did not evaluate current clinical practices or decisions made based on the Gram stain

Strengths

- Used objective criteria for diagnosis of pneumonia
- Analyzed clinically relevant endpoints from microbiology data

Conclusions

- Pneumonia should continue to be a clinical diagnosis considering the inconsistency of establishing a microbiologic diagnosis
- The utility of the respiratory specimen Gram stain for predicting final culture is still unproven
- Respiratory specimen Gram stains should not be used to alter empiric antimicrobial regimens until the culture results

References

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