Validation of Methicillin-Resistant *Staphylococcus aureus* (MRSA) Risk Factors in Predicting MRSA Community-Acquired Pneumonia at an Academic Medical Center

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INTRODUCTION

- The 2019 Infectious Diseases Society of America (IDSA) community-acquired pneumonia (CAP) guidelines recommend anti-methicillin-resistant *Staphylococcus aureus* (MRSA) therapy in patients with CAP based on previously identified risk factors for MRSA.[1]
- Risk factors include previous respiratory MRSA infection, intravenous antibiotics and hospitalization within the past 90 days.[1]
- The IDSA CAP guidelines recommend to validate these MRSA risk factors at the local level.[1]

OBJECTIVE

- To assess the ability of the MRSA risk factors identified in the IDSA CAP guidelines to predict MRSA pneumonia in a cohort of patients with CAP at our institution

METHODS

- **Study Design**: Single-center, retrospective cohort study between 1/1/2016-3/30/2020.
- **Study Location**: SUNY Upstate University Hospital is a 472-bed, level 1 trauma, tertiary care, academic medical center in Syracuse, NY.
- **Inclusion criteria**: ≥18 years old, diagnosed with CAP based on clinical and radiographic evidence, and had a MRSA nasal screen and respiratory culture obtained on admission.
- **Exclusion criteria**: Diagnosis of CAP was not met, respiratory cultures were not obtained within 48 hours of antibiotic initiation, aspiration pneumonia, and cystic fibrosis.
- **Data Collection**: Demographic data; pertinent culture results, vital signs, and laboratory results; history of hospitalization and IV antibiotics within last 90 days; and history of a positive MRSA nasal screen or MRSA lower respiratory tract culture within last year.
- **Data Management**: All data was collected in Microsoft Excel by a single investigator trained on data collection with regular oversight to ensure accuracy and consistency.
- **Statistical Analysis:** Sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), and positive and negative likelihood ratios (LR) were calculated to estimate risk factors to predict MRSA CAP using Vasser Stats 2019.
- Pre/post-test odds and pre/post-test probabilities were calculated using Excel 2019.
- MRSA CAP pre- and post-test probability was estimated if a risk factor had 95% CI for a + LR or – LR not containing one.
- **Ethics**: Deemed exempt by our Institutional Review Board.

RESULTS

Figure 1. Patient Inclusion

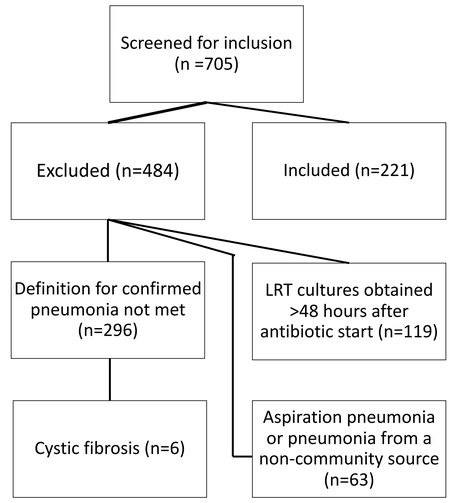

Table 1. Demographics, Clinical Characteristics, and Microbiology

Demographics	
Age (years), mean (SD)	62.1 (16.9)
Weight (kg)	81.6 (29.6)
Male gender, n (%)	131 (59.3)
Clinical Characteristics	
Temperature (F), mean (SD)	98.6 (2.0)
Respiratory rate (breathes per minute), mean (SD)	22 (5.8)
White blood cell count (/mm^3), mean (SD)	14.9 (15.4)
Oxygen saturation (%), mean (SD) *	92.2 (9.6)
On room air, n (%)	141 (63.8)
Increased sputum production, n (%)	155 (70.1)
Cough, n (%)	192 (86.9)
Microbiologic Information	
MRSA Screen Methodology	
Nasal Swab – Culture, n (%)	164 (74.2)
Nasal Swab – PCR, n (%)	57 (25.8)
LRT culture positive for MRSA, n (%)	8 (3.6)
Sputum culture, n (%)	7 (87.5)
Bronchoalveolar lavage, n (%)	1 (12.5)
LRT culture negative for MRSA, n (%)	213 (96.4)
Sputum culture, n (%)	192 (90.1)
Bronchoalveolar lavage, n (%)	5 (2.3)
Endotracheal aspirate, n (%)	16 (7.5)

Table 2. Sensitivity, Specificity, PPV, NPV, PLR, and NLR

	Risk Factor Prior to CAP Admission		Risk Factor Following CAP Admission
	History of MRSA infection or colonization past year	Hospitalization & IV antibiotics past 90 days	Post-admission MRSA nasal screen
True Positive, n	3	3	6
False Positive, n	4	42	23
True Negative, n	209	171	190
False Negative, n	5	5	2
Sensitivity (95% CI)	38 % (10 – 74%)	38 % (10 – 74%)	75 % (36 – 96%)
Specificity (95% CI)	98 % (95 – 99%)	80 % (74 – 85%)	89 % (84 – 93%)
Positive Predictive Value (95% CI)	43 % (12 – 80%)	7 % (2 – 19%)	21 % (9– 40%)
Negative Predictive Value (95% CI)	98 % (94 – 99%)	97 % (93 – 99%)	99 % (96 – 99%)
Positive Likelihood Ratio (95% CI)	20 (5.3 – 74.8)	1.9 (0.74 – 4.84)	6.9 (4.0– 12.1)
Negative Likelihood Ratio (95% CI)	0.64 (0.37 – 1.1)	0.78 (0.45 – 1.33)	0.28 (0.08 – 0.93)

Table 3. Pre- and Post-Test Probability for MRSA in CAP

	Risk Factor Prior to CAP Admission	Risk Factor Following CAP Admission
	History of MRSA lower respiratory tract infection or colonization past year	Post-admission MRSA nasal screen
Pre-test Probability	3.6 %	3.6%
Pre-test Odds	0.0376	0.0376
Post-test Odds Positive	0.75	0.2609
Post-test Odds Negative	N/A	0.0105
Post-test Probability Positive	42.9%	20.7%
Post-test Probability Negative	N/A	1.0%

DISCUSSION

- To our knowledge, this is the first study to validate the 2019 IDSA CAP guidelines recommendation for MRSA coverage at a single institution.
- We observed a low prevalence of MRSA among hospitalized patient with CAP in our study.
- Our study revealed that MRSA was strongly predicted by a prior respiratory isolation of MRSA which is consistent with current literature.[2,3]
- Negative post-admission MRSA nasal screening suggested low probability for CAP due to MRSA, which is consistent with the high NPV for MRSA nasal screening to aid in ruling out MRSA pneumonia.[4]
- Positive post-admission MRSA nasal screening suggested moderate probability for CAP due to MRSA[4,5]
- In contrary to previous studies, our study did not find that MRSA was predicted by hospitalization requiring IV antibiotics in the past 90 days.[2,3]
- MRSA was moderately predicted by hospitalization and IV antibiotics in past 90 days only if the patient had a positive nasal screen on admission.
- Overall, our analysis supports using the 2019 IDSA CAP recommendations as a framework for determining which patients warrant anti-MRSA treatment.[1]

CONCLUSIONS

- Risk factors including history of MRSA isolated from a respiratory specimen, and positive post-admission MRSA nasal screen were validated as significant risk factors; receipt of IV antibiotics during hospitalization within the past 90 days was not shown to be a risk factor for MRSA CAP based on our institutional data
- Other institutions should consider validating these risk factors to determine which patients would benefit from anti-MRSA therapy at their institution

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Disclosures

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