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REVIEW

Urinary Antigen Testing for Respiratory Infections: Current Perspectives on Utility and Limitations

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Abstract: Pneumonia is a leading cause of hospitalization and death due to infection worldwide. *Streptococcus pneumoniae* and *Legionella pneumophila* remain among the most commonly identified bacterial pathogens. Unfortunately, more than half of all pneumonia cases today lack an etiologic diagnosis due to limitations in traditional microbiological methods like blood and sputum cultures, which are affected by poor sample collection, prior antibiotic administration, and delayed processing. Urinary antigen tests (UATs) for *S. pneumoniae* and *L. pneumophila* have emerged as powerful tools for improving the diagnosis of bacterial respiratory infections, enabling physicians to administer early directed therapy and improve antimicrobial stewardship. UATs are simple, rapid, and non-invasive diagnostic tests with high specificity (>90%) and moderate sensitivity (<80%). The potential impact of urinary antigen testing is especially significant for respiratory infections caused by *Legionella*. While all recommended community-acquired pneumonia (CAP) therapies are adequate for treating pneumococcal pneumonia, only certain antibiotics are effective against *Legionella*. Delayed therapy for *Legionella* is associated with worse clinical outcomes, which underscores the importance of rapid diagnostic methods like UATs. Despite their potential impact, current American Thoracic Society and Infectious Diseases Society of America (ATS/IDSA) guidelines argue against the routine use of urinary antigen testing for *S. pneumoniae* and *L. pneumophila*, except in patients with severe CAP and those with epidemiological risk factors for *Legionella*. Further research is necessary to evaluate the impact of early targeted treatment due to positive UAT results, as well as optimal strategies for UAT utilization. The purpose of this review is to summarize the UATs available for bacterial respiratory infections, describe current guidelines on their usage, and assess their impact on clinical outcomes and targeted therapy.

Keywords: urinary antigen test, *Streptococcus pneumoniae*, *Legionella pneumophila*, pneumonia, impact

Introduction

Pneumonia is the leading cause of hospitalization and death due to infection among adults in the United States.[1] In 2015, the Etiology of Pneumonia in the Community (EPIC) study found that the annual incidence of community-acquired pneumonia (CAP) was 24.8 cases per 10,000 adults, with the highest rates among individuals 65–79 years of age (63 cases per 10,000) and those >80 years of age (164 cases per 10,000).[1,2] While *Streptococcus pneumoniae* remains the most commonly identified bacterial pathogen, other important causes include *Mycoplasma pneumoniae, Staphylococcus aureus, Legionella pneumophila*, Enterobacteriaceae, and *Haemophilus influenzae*.[1,3]

Early identification of the causative pathogen in CAP is crucial to guide antibiotic therapy, prevent the emergence of antimicrobial resistance, and reduce drug toxicities. Unfortunately, approximately 50–60% of all CAP cases still lack an etiologic diagnosis due to limitations in traditional microbiological methods, such as blood/sputum cultures, which are affected by poor sample collection, delayed processing, and prior antibiotic administration.[1,2,4] Cultures usually take ≥48 hours before a specific bacterium can be identified. Moreover, among patients hospitalized with CAP, the rate of positive blood cultures is low, ranging from 4.7 to 16%,[5–13] while the diagnostic yield of sputum cultures is <50%.[14–16] One

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recent meta-analysis of 24 studies including 4533 adult CAP patients found that a bacterial pathogen was identified in only 36% of sputum specimens.[17]

Urinary antigen tests (UATs) have emerged as a promising alternative for improving the diagnosis of respiratory infections caused by *Streptococcus pneumoniae, Legionella pneumophila*, and *Histoplasma capsulatum*.[2,18] UATs are non-culture-based tests that detect antigens shed from pathogens and excreted in the urine. UATs have several advantages over traditional microbiological methods; they are simple, non-invasive, rapid, and unaffected by prior antibiotic administration.[19] This review describes the current status of UATs, current guidelines on their usage, test characteristics, and their impact on targeted therapy and clinical outcomes.

Urinary Antigen Test for the Diagnosis of Pneumococcal CAP

The pneumococcal UAT detects the presence of the C-polysaccharide antigen common to all serotypes of *S. pneumoniae* in the urine of patients with pneumococcal pneumonia.[2,18,20] The most widely used immunochromatographic membrane assay, BinaxNOW (Abbott, USA), was the first pneumococcal UAT to be licensed by the US Food and Drug Administration in 1999.[2,21,22] Since then, several other assays have been developed, including Uni-Gold (Trinity Biotech, USA), ImmuView (SSD, Denmark), and the Sofia fluorescence immunoassay (FIA; Quidel, San Diego).[23–27] ImmuView offers the unique advantage of simultaneously detecting *S. pneumoniae* and *L. pneumophila* serogroup 1 antigens in a single test.[23,24]

The utilization of pneumococcal UAT varies considerably across the United States. A recent retrospective cohort study of patients admitted with CAP to 170 US hospitals demonstrated that hospital rates of UAT utilization ranged from 0 to 69%, highlighting the lack of consensus on when to use UAT.[28] The 2007 and 2019 American Thoracic Society and Infectious Diseases Society of America (ATS/IDSA) guidelines argue against the routine use of pneumococcal UATs because small randomized trials have failed to show outcome-related benefits as a result of UAT and pathogen-directed therapy.[29–31] Moreover, narrowing therapy in response to a positive UAT has been associated with a higher risk of clinical relapse.[31] However, larger observational studies have demonstrated mortality reduction in patients who undergo UAT, with this association becoming more marked as the level of CAP severity increased.[32,33] Thus, the ATS/IDSA guidelines make a weak recommendation to perform pneumococcal UAT only in adults with severe CAP.[29,30] Pneumococcal UAT also appears to have greater diagnostic yield in patients with severe CAP.[29,34]

Interestingly, Schimmel et al found no significant differences in UAT rates between ICU and non-ICU patients, suggesting that ATS/IDSA guidelines have had minimal impact on physician ordering.[28] A recent large prospective study also found that patients who met ATS/IDSA indications for UAT infrequently had a positive UAT result (positive test prevalence of 4.1%).[35] These findings suggest that current recommended indications for UAT still identify a low-risk population, leading to unnecessary tests and wasted resources.[36]

Advantages

Pneumococcal UATs have several advantages. They can produce results within 15 minutes of urine sample collection, are non-invasive, easy to perform, and unaffected by prior antibiotic administration.[29] They also have a relatively low cost; the BinaxNOW pneumococcal UAT costs approximately USD$17 according to the Centers for Medicare & Medicaid Services.[35,37]

Disadvantages

At a cost of USD$17 per test, the pneumococcal UAT costs approximately USD$425 per positive result.[35,38,39] Additionally, false-positive results can be seen in patients with a CAP episode within the previous 3 months, in children with chronic respiratory diseases who are colonized with *S. pneumoniae*, and in patients who received the pneumococcal polysaccharide vaccine within the previous 48 hours.[29,40] Therefore, pneumococcal urinary antigen testing is typically not recommended in individuals vaccinated against *S. pneumoniae* in the last 5 days.[18]

Test Characteristics

Several meta-analyses and studies have estimated the sensitivity and specificity of the BinaxNOW assay. Most have demonstrated moderate sensitivity (<80%) and high specificity (>90%). The manufacturer's website reports a sensitivity of 86% and specificity of 94%, based on retrospective data.[41] One meta-analysis of 27 studies by Sinclair et al yielded a pooled sensitivity of 74.0% (95% credibility interval [CrI], 66.6–82.3%) and specificity of 97.2% (95% CrI, 92.7–99.8%) after adjusting for variable reference standards used across the studies.[42] The authors noted the presence of substantial heterogeneity. Another meta-analysis conducted in the same year included one additional study but yielded similar results, with a pooled sensitivity of 75% (95% CI, 71–79%) and specificity of 95% (95% CI, 92–98%).[43] More recent studies have reported sensitivities and specificities in the same range.[23,26,27,44] Overall, pneumococcal UAT has higher sensitivity than culture and very high specificity, which makes it a useful tool for diagnosing pneumococcal pneumonia.

Some evidence suggests that the sensitivity of the BinaxNOW pneumococcal UAT decreased following the introduction of the 13-valent polysaccharide conjugate vaccine (PCV13) in late 2011. Shoji et al evaluated the sensitivity of the pneumococcal UAT in three time periods – 2001 to 2005 (early use of the 7-valent pneumococcal conjugate vaccine [early PCV7]), 2006 to 2010 (late PCV7), and 2011 to 2015 (early PCV13). The estimated sensitivity for each time period was 76.4%, (95% CI, 70.5–82.4%), 77.9% (95% CI, 74.4–81.4%), and 60.5% (95% CI, 55.4–65.6%), respectively.[45] Another more recent study of 446 patients also showed a significant, gradual decrease in sensitivity from 2001 (81.3%) to 2015 (48.7%).[46]

Predictors of Pneumococcal UAT Positivity

Multiple studies have explored factors associated with pneumococcal UAT positivity in adult patients admitted with CAP. Molinos et al[44] found that female sex, heart rate >125 bpm, systolic blood pressure <90 mmHg, SaO2 <90%, blood urea nitrogen >30 mg/dL, pleuritic chest pain, chills, pleural effusion, and absence of antibiotic treatment were significant predictors of pneumococcal UAT positivity. With at least 6 of these predictors, the probability of pneumococcal UAT positivity was 52%. In another study, factors associated with a negative UAT result included male sex and high white blood cell count.[46]

Impact of Pneumococcal UATs

The use of pneumococcal UATs has been shown to increase the rates of etiologic diagnosis of CAP by approximately 20%.[47,48] To further highlight the markedly increased diagnostic yield, in one 2015 prospective study, of the 916 cases of pneumococcal CAP, approximately 70% were diagnosed exclusively by UAT.[44] Pneumococcal UATs have the potential to improve antimicrobial stewardship through rapid identification of *S. pneumoniae*, allowing for de-escalation of antibiotic therapy. De-escalation has been shown to be safe and effective in CAP patients, even in those with bacteremia, with multiple observational studies demonstrating no higher risk of clinical failure or mortality.[49–52] Rather, antibiotic de-escalation can reduce length of stay (LOS), costs, drug toxicities, and the development of antimicrobial resistance.[49,51,53]

Still, the impact of UAT on clinical outcomes remains unclear. One small randomized trial of 177 CAP patients found no difference between pathogen-directed and empiric therapy.[31] In this study, CAP patients were randomized to either empiric (n=89) or targeted (n=88) treatment on the basis of UAT for *S. pneumoniae* and *L. pneumophila*. UAT was positive in only 25 of the 88 patients assigned to the targeted treatment arm (22 *S. pneumoniae*, 3 *L. pneumophila*), and the remaining patients received empiric treatment. Comparisons between patients who were empirically treated and patients who were treated according to their UAT result demonstrated no statistically significant differences in mortality, ICU admission, LOS, and adverse events, but targeted treatment was associated with a higher risk of clinical relapse (12% vs 3%, p=0.04). This study had several important limitations.[54] First, the sample size was small, so it was underpowered to detect differences in mortality, ICU admission, and LOS. Additionally, all 177 patients included in the study were treated identically upon admission with a β-lactam + macrolide or a respiratory fluoroquinolone. Only those patients who achieved clinical stability between 2–6 days after admission and could tolerate oral food were randomly assigned to one of the two treatment arms based on UAT results. Assuming the absence of significant drug resistance, treatment with a β-lactam + macrolide or a respiratory fluoroquinolone would have been effective for the majority of patients included in the study, given that only 1 out of the 177 patients included required ICU admission.[30] Thus, the 25 UAT-positive patients who received pathogen-directed therapy likely received multiple doses of appropriate antimicrobial treatment in their first few days of admission.[54] Most importantly, pathogen-directed therapy for a positive pneumococcal UAT result consisted of oral amoxicillin, which is not the preferred agent for inpatients in the United States.

On the other hand, larger observational studies have demonstrated improved outcomes in patients who undergo UAT.[32,33] After adjusting for patient and hospital characteristics, performance of guideline-recommended UATs has been associated with reduced in-hospital mortality,[32] decreased 30-day mortality,[32,33] and shorter LOS.[33,55] The mechanism by which these benefits occur, however, is unclear and could represent confounding. While it is possible that UAT allowed physicians to select pathogen-directed antibiotics as initial treatment, thereby decreasing adverse events often seen with broader-spectrum antibiotic use,[28] UAT utilization may simply reflect the implementation of other standard care processes that lead to improved outcomes.

Given the uncertainty as to whether pneumococcal UATs improve outcomes, some suggest that pneumococcal UAT should be used rarely in clinical practice.[36] Because positive test prevalence is low (4–15%), there may be limited opportunity for UAT to improve antimicrobial stewardship.[22,28,36,37] This is compounded by the fact that clinicians frequently ignore positive test results and choose not to de-escalate therapy. Studies have shown that only 32–38% of UAT-positive patients have their antibiotic treatment narrowed to targeted therapy against *S. pneumoniae*.[28,48,56] Although it makes sense not to order a test that will be ignored, this appears to be an issue of education, rather than a flaw with the test itself. One study found that hospitals with higher rates of UAT testing were more likely to de-escalate patients following a positive UAT result.[28]

Urinary Antigen Test for the Diagnosis of *Legionella* CAP

Legionella pneumophila is another important cause of CAP, accounting for approximately 2 to 3.4% of all CAP cases in the United States.[57] With a mortality rate of 5–30% in hospitalized patients and up to 50% in the ICU, pneumonia caused by *Legionella* species (Legionnaire's disease) is a serious pulmonary infection.[58] Since its identification in the US in 1976, there has been a dramatic increase in the proportion of *Legionella* cases worldwide.[59] The etiologic diagnosis of Legionnaire's disease has historically been challenging. While culture of lower respiratory tract secretions (eg, sputum, bronchoalveolar lavage) remains the gold standard diagnostic approach, cultures take at least 3–5 days and yield no result in up to 46% of cases.[58] The *Legionella* UAT has thus emerged as a rapid, effective alternative and has become the most commonly used laboratory test for diagnosing Legionnaire's disease.[60,61] In Europe, for example, approximately 80% of Legionnaire's disease cases were diagnosed by UAT from 2011–2015.[62]

There are several different technologies for antigen detection. Immunochromatography-based urinary antigen tests like the BinaxNOW *Legionella* Antigen Card (Abbott, USA) and ImmuView *S. pneumoniae* and *L. pneumophila* assays (SSD, Denmark) produce a visible result for interpretation, while fluorescent immunoassay (FIA)-based urinary antigen tests like the Sofia *Legionella* FIA (Quidel, San Diego) and STANDARD F *Legionella* FIA (SD Biosensor, South Korea) require an automated reader for interpretation.[63] All available *Legionella* UATs detect *L. pneumophila* serogroup 1 in urine samples of patients with Legionnaire's disease.[18] This subtype is responsible for 80–95% of community-acquired legionellosis in the United States and Europe, but only approximately 50% of cases in Australia and New Zealand.[29,64,65] Antigens can be detected on the first day of illness and persist for weeks to months.[29,66] The 2019 ATS/IDSA guidelines recommend the use of *Legionella* UAT only in adults with severe CAP or in patients with epidemiological risk factors, including association with a *Legionella* outbreak or recent travel.[30] For patients with severe CAP, delays in coverage of less-common pathogens like *Legionella* can result in more serious consequences, so the potential benefit of UAT is larger when the results can be returned rapidly. *Legionella* UAT also appears to have greater diagnostic yield in severe CAP patients.[29,67] Similar to their rationale for pneumococcal UAT, the ATS/IDSA guidelines argue against routine use of *Legionella* UAT because small randomized trials have failed to demonstrate improved outcomes with pathogen-directed therapy, and narrowing therapy in response to a positive UAT could increase the risk of clinical relapse.[5,31] This recommendation is based on a low quality of evidence. As noted, these studies included only a handful of patients with Legionnaire's disease.

Advantages

The *Legionella* UAT has several advantages that have made it the most commonly ordered test for the diagnosis of Legionnaire's disease.[59,68] *Legionella* UATs are rapid, non-invasive, simple to perform, and unaffected by prior antibiotic exposure.[18] In particular, *Legionella* UATs allow for early adequate treatment of patients with severe legionellosis; these patients often receive broad-spectrum antibiotics targeting methicillin-resistant *Staphylococcus aureus* and resistant gram-negative organisms, which usually do not cover *Legionella* at all.[69]

Disadvantages

The vast majority of *Legionella* UATs are only able to detect *L. pneumophila* serogroup 1.[63,70] While *L. pneumophila* serogroup 1 accounts for over 80–95% of legionellosis cases in most of the US and Europe, other species and serotypes predominate in certain areas like the southern and Pacific United States, New Zealand, and Australia.[29,64,71] Given that there are 58 different *Legionella* species and over 70 serogroups, the usefulness of *Legionella* UAT thus decreases as the prevalence of serogroup 1 decreases.[72] However, in 2019, a novel urinary antigen test kit called Ribotest Legionella (Asahi Kasei Pharma Corporation, Japan) was launched in Japan, which can identify all serogroups of *L. pneumophila* and *Legionella* species other than *L. pneumophila*.[72] While further studies are needed to assess the impact and usefulness of this novel kit in other countries, this new urinary antigen test can improve early and appropriate diagnosis of Legionnaire's disease due to non-*L. pneumophila* serogroup 1, thereby improving prognosis. Another disadvantage of the *Legionella* UAT is that false-positive results can be seen in patients with recent Legionnaire's disease due to prolonged antigen excretion.[70] In one study of 61 patients with Legionnaire's disease diagnosed by UAT, detectable antigenuria persisted for more than 60 days in approximately 10% of the patients.[61] One patient had prolonged excretion for almost one year after initial diagnosis. Factors associated with prolonged antigen excretion included pharmacological immunosuppression and persistence of fever for more than 72 hours after treatment initiation.

Test Characteristics

Manufacturer-reported sensitivities of FDA-approved *Legionella* UATs range between 87% and 97%, while specificities range from 86–100%.[18] Subsequent studies of culture-proven Legionnaire's disease, however, have reported much lower sensitivities of 75–80%, but a consistently high specificity of nearly 100%.[2] Comparisons between the different commercially available *Legionella* urinary antigen tests have shown that immunochromatography- and fluorescent immunoassay-based UATs perform very similarly to each other.[63] One meta-analysis of 30 studies yielded a pooled sensitivity of 74.0% (95% CI, 68–81%) and a specificity of 99.1% (95% CI, 98.4–99.7%).[73] The authors note that the poor quality of included studies and presence of publication bias may have led to an overestimation of the pooled estimates.

Predictors of Legionella UAT Positivity

Because *Legionella* is an uncommon cause of CAP, accounting for approximately 2.7% of cases, it is helpful to identify patients at increased risk.[57] The ATS/IDSA CAP guidelines cite recent travel and local outbreaks as important risk factors. However, several studies have identified other clinical risk factors. In one small retrospective cohort study, Roed et al found that positive *Legionella* UATs were associated with hyponatremia, confusion, CURB-65 score >3, elevated C-reactive protein (CRP), and high-grade fever.[74] Factors associated with a negative *Legionella* UAT included normal heart rate, absence of sepsis, and normal pulmonary auscultation.

Several scoring systems have been developed to predict Legionnaire's disease.[75,76] Fiumefreddo et al determined that high body temperature, absence of sputum production, hyponatremia, elevated lactate dehydrogenase (LDH), elevated CRP, and thrombocytopenia were independent predictors of *Legionella* CAP, defined by a positive *Legionella* UAT or a positive culture or PCR of a respiratory sample.[75] However, while useful for predicting *Legionella* pneumonia due to *L. pneumophila* serogroup 1, the utility of this scoring system for predicting disease due to non-*L. pneumophila* serogroup 1 has been questioned.[77] Miyashita et al more recently developed and validated a simple *Legionella* score to identify patients with *Legionella* pneumonia based on clinical and laboratory findings, assigning one point for each of the following six parameters: male sex, absence of cough, dyspnea, CRP >18 mg/dL, LDH >260 U/L, and sodium <134 mmol/L.[76] In their validation cohort, the presence of at least 3 points had a sensitivity of 93% and specificity of 75% for diagnosing *Legionella* CAP.

Impact of Legionella UATs

As with any diagnostic test, the impact of *Legionella* UAT depends on its application in clinical practice. While all CAP therapies are usually adequate for the treatment of pneumococcus, one recent analysis of patients admitted with pneumonia to 177 US hospitals demonstrated that nearly 25% of patients who were eventually diagnosed with Legionnaire's disease did not receive adequate empiric coverage for *Legionella* during their first two days of hospitalization.[69] Even though current ATS/IDSA guidelines recommend empiric treatment that covers *Legionella*, this recommendation is frequently ignored in clinical practice.[30] This is a serious issue, as delayed therapy for *Legionella* pneumonia has been associated with worse clinical outcomes, including increased risk for mortality.[69,78] Testing for *Legionella* with UAT can therefore speed diagnosis and facilitate early directed therapy. This is especially important for patients with severe CAP and those at risk for multi-drug resistant organisms, as their treatment often does not cover *Legionella*. In one study of 141 patients hospitalized with *Legionella* pneumonia, Lettinga et al evaluated the effect of timely targeted treatment during a large outbreak of Legionnaire's disease in the Netherlands.[79] In patients with positive *Legionella* UAT, adequate therapy within 24 hours of hospitalization reduced the risk of ICU admission and death by 38%. Timely detection of *Legionella* species also enables prompt notification of public health services to identify an environmental source and prevent an outbreak.

Despite this potential benefit, current ATS/IDSA guidelines argue against routine use of UAT.[29,30] This stands in contrast to the British, German, and Spanish CAP guidelines, which recommend use of *Legionella* UAT for all patients admitted with CAP.[80–82] The ATS/IDSA rationale was based on two small randomized trials which failed to demonstrate improved outcomes with *Legionella* UAT and pathogen-directed therapy.[5,31] These studies, however, were severely underpowered. As previously described, one trial[31] had only 3 patients with *L. pneumophila*, while the other[83] only enrolled 7 patients. In this case, the absence of evidence should not be construed as evidence of absence.

While the positive test prevalence of *Legionella* UAT is low (1.5–4.6%), efficiency of testing could be improved by focusing on patients with risk factors for Legionnaire's disease.[69,84,85] One large retrospective study showed that patients with known risk factors (eg, hyponatremia, diarrhea, smoking) were tested only slightly more often than those without.[69] Additionally, even though *Legionella* species are known to thrive in warm, humid summer months, testing patterns did not vary by season. Together, these findings underscore the opportunity to enhance efficiency of *Legionella* urinary antigen testing by incorporating known risk factors into ordering decisions.[69]

Improving the efficiency of testing is important, as studies have estimated the cost per positive *Legionella* UAT result to be between USD$850 to $12,640, depending on the local incidence of *Legionella*.[35,58,71,86] Routine *Legionella* testing may not be cost-effective in low incidence areas like the southern and Pacific United States. For example, in a study from central Texas, a positive *Legionella* antigen was found in only 17 (0.3%) of the 5807 patients admitted with pneumonia.[71] Consequently, the cost to diagnose a single case of *Legionella* pneumonia was USD$12,640.

Conclusion

Community-acquired pneumonia remains the leading infectious cause of hospitalization and death worldwide, with *Streptococcus pneumoniae* and *Legionella pneumophila* being among the most common causative pathogens. In recent years, overuse of broad-spectrum empirical antibiotics has contributed to the emergence of antibiotic resistance in patients with CAP.[87] While the development of new antimicrobial agents is one possible solution, pathogen-directed treatment should also play a role. Pathogen-directed treatment has several advantages, including reduced pressure for the development of antimicrobial resistance, fewer adverse drug effects, and decreased complications like *Clostridium difficile* infections.[28]

UATs have revolutionized the diagnosis of pneumococcal and *Legionella* CAP, making it possible for physicians to adopt policies of administering early targeted treatment. UAT holds several advantages over traditional microbiological methods for establishing bacterial etiology, including rapid turnaround time, high specificity, non-invasiveness, convenience, and relatively low cost (~$17-30 per test).[35,71] Despite guidelines put forth by ATS/IDSA, there remains a clear lack of consensus on when to use this test.[28] Importantly, even when a causative pathogen has been identified through UAT, few providers incorporate a positive test result into decision-making, reflecting a missed opportunity to improve antimicrobial stewardship.[28,48,56] This highlights the importance of physician education to encourage administration of narrow-spectrum antibiotics when appropriate. Multiple studies have shown that antibiotic de-escalation is safe and effective in CAP patients, even in those with bacteremia.[49–52]

Studies to date have not clearly established the clinical impact of antibiotic treatment modification due to UAT results. Small, randomized trials have failed to demonstrate benefits from UAT and pathogen-directed therapy,[31,83] but they were grossly underpowered, among other important limitations.[54] Further research is necessary to elucidate the impact of targeted treatment following UAT.

UATs are not without limitations. From a cost-effectiveness perspective, the low positive test prevalence of UAT results in high cost per positive result, underscoring the need to improve efficiency of testing. The most commonly used BinaxNOW *Legionella* UAT (Abbott, USA) is also only able to detect the most common subtype, *L. pneumophila* serogroup 1, which may lead to missed diagnoses.[70] However, the novel Ribotest *Legionella* UAT, which can detect all serogroups of *L. pneumophila*, is gaining popularity in the global market and can enable early and appropriate diagnosis of *Legionella* pneumonia due to non-*L. pneumophila* serogroup 1.[72] Finally, the modest sensitivity of UATs (<80%) may be too low for physicians to confidently exclude *S. pneumoniae* or *L. pneumophila* as the etiologic agent. Therefore, while UATs have greatly increased our ability to reliably test for *S. pneumoniae* or *L. pneumophila*, they should likely be used in combination with other diagnostic tests.

Disclosure

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