Impact of *Streptococcus pneumoniae* Urinary Antigen Testing in Patients With Community-Acquired Pneumonia Admitted Within a Large Academic Health System

Adam Greenfield, Kassandra Marsh, Justin Siegfried, Ioannis Zacharioudakis, Nabeela Ahmed, Arnold Decano, Maria E. Aguero-Rosenfeld, Kenneth Inglima, John Papadopoulos, and Yanina Dubrovskaya

1Department of Pharmacy, New York University Langone Health, New York, New York, USA, 2Division of Infectious Diseases, Department of Medicine, New York University Langone Health, New York, New York, USA, 3Department of Pharmacy, New York University Langone Hospital–Brooklyn, Brooklyn, New York, USA, and 4Department of Pathology, Grossman School of Medicine, New York University, New York, New York, USA

**Background.** Limited data support use of pneumococcal urinary antigen testing (PUAT) for patients with community-acquired pneumonia (CAP) as an antimicrobial stewardship tool. At our institution, CAP guidelines and admission order set were standardized to include universal PUAT.

**Methods.** This was a retrospective study of adults hospitalized in 2019 who had PUAT performed. We compared incidence and timing of de-escalation in PUAT-positive vs -negative groups and described patients’ outcomes.

**Results.** We evaluated 910 patients, 121 (13.3%) of whom were PUAT positive. No difference in baseline characteristics, including severity of illness, was observed between groups. Initial de-escalation occurred in 82.9% and 82.1% of PUAT-positive and -negative patients, respectively (P = .749). Median time to de-escalation was shorter in the PUAT-positive group (1 [interquartile range [IQR], 0–2] day vs 1 [IQR, 1–2] day, P = .01). Within 24 hours of PUAT, more patients in the PUAT-positive group had atypical agent discontinuation (61.3% vs 47.2%, P = .026) without difference in methicillin-resistant *Staphylococcus aureus* (MRSA) agent discontinuation (or antipseudomonal de-escalation). Among the PUAT-positive group, unadjusted analysis demonstrated shorter median length of stay in patients who were de-escalated compared to those who were not (6 [IQR, 4–10] vs 8 [IQR, 7–12] days, P = .0005), without difference in the incidence of *Clostridoides difficile*, in-hospital mortality, or 30-day infection-related readmission.

**Conclusions.** We observed earlier de-escalation in the PUAT-positive group. This seems to be due to discontinuation of atypical rather than anti-MRSA or antipseudomonal coverage. Further antimicrobial stewardship interventions are warranted.

**Keywords.** antimicrobial stewardship; community-acquired pneumonia; pneumococcal urinary antigen test.
guidelines do not routinely recommend the use of PUAT, except in patients presenting with severe CAP. Real-world usage of PUAT, however, may vary from guideline recommendations as represented by Schimmel et al [6]. Recognized potential concerns include disease relapse after early de-escalation, and a lack of clinical benefit derived from randomized trial data [4]. Although PUAT has the potential for quicker time to pathogen recognition and initiation of targeted antimicrobial regimens, and has demonstrated reduction in mortality in observational studies, questions remain regarding the optimal patient population for PUAT [9–11].

At New York University Langone Health (NYULH), CAP guidelines (included in the Supplementary Materials) were developed by the Antimicrobial Stewardship Program (ASP) in December 2016. A third-generation cephalosporin, ceftriaxone, with cefpodoxime as oral switch, plus azithromycin was recommended as the empiric treatment of choice during the study period. The ASP team collaborated with Infectious Diseases, Internal Medicine, and the Clinical Microbiology Laboratory to advise PUAT for all patients presenting with CAP. Additionally, a CAP admission order set was developed to standardize diagnostic testing, including universal PUAT. Given the efficiency and quick turnaround time for the PUAT, we hypothesize that the use of PUAT can improve the time to targeted therapies for S pneumoniae CAP, including de-escalation of broad-spectrum antibiotics. Therefore, the objective of our study was to utilize antimicrobial use data to describe patients with both positive and negative PUAT, describe antimicrobial use during admission for CAP, and evaluate patients’ outcomes.

METHODS

Study Design and Population
This study was a retrospective chart review of adult patients admitted to the NYULH System, Tisch (800-bed) and Brooklyn (450-bed) campuses, between January and December 2019, who were hospitalized for the treatment of CAP and had a PUAT performed as part of the diagnostic workup. Patients were identified through a database of microbiological testing results and were excluded if they did not have a primary admitting diagnosis of pneumonia, did not receive antibiotics during their index admission, and had a PUAT performed >7 days into the admission. Patients who did not require hospital admission (eg, emergency department [ED] and/or observation unit stay only) were not included. Patients with a blood culture positive for S pneumoniae in the setting of negative PUAT were excluded. Additionally, patients with infections due to non-S pneumoniae pathogens identified through blood, urine, and sputum cultures as well as patients with positive Legionella urinary antigen and Mycoplasma pneumoniae immunoglobulin M antibodies were also excluded.

Study Variables
Baseline demographic and clinical characteristics were collected including age, sex, comorbidities, and severity of presentation, as measured by the Pneumonia Severity Index (PSI) and Charlson Comorbidity Index (CCI). Time to PUAT from admission and inpatient antimicrobial exposure defined as days of therapy (DOT) during entire admission were also assessed and described. The primary outcome was incidence and timing of de-escalation of antimicrobials following PUAT result. Secondary outcomes evaluated hospital length of stay (LOS), development of Clostridium difficile infection (CDI) and infection-related readmission within 30 days of index admission and in-hospital mortality in patients with a positive PUAT.

Study Definitions
Initial de-escalation was assessed within the first 3 DOT and defined as (1) a change in the antimicrobial regimen to a narrower-spectrum agent (ie, de-escalation of antipseudomonal coverage), (2) discontinuation of MRSA coverage, or (3) discontinuation of atypical coverage. Pseudomonas aeruginosa coverage included use of antipseudomonal β-lactams (piperacillin-tazobactam, cefepime, meropenem), amikacin, or aztreonam. For the purpose of this study, fluoroquinolones were not included as antipseudomonal coverage given their primary use per NYULH CAP guidelines as alternatives to ceftriaxone in patients with severe penicillin or cephalosporin allergies. MRSA coverage was defined as the use of vancomycin or linezolid, and atypical coverage was defined as the use of azithromycin or doxycycline.

Of note, ED patients who trigger sepsis alert criteria (ie, presence of both infection and a systemic inflammatory response) are promptly initiated with broad-spectrum (often anti-MRSA and antipseudomonal) coverage per the NYULH sepsis protocol. Traditionally, at our institution, piperacillin-tazobactam is considered the workhorse antipseudomonal agent. During the time of the study period, ceftriaxone/cefpodoxime had been the most common agent for de-escalation in our clinical practice, including narrowing from piperacillin-tazobactam. Common barriers to use of penicillin, ampicillin, or ampicillin-sulbactam include multiple daily doses, higher fluid volume, and sodium content.

Statistical Analyses
The initial cohort was divided on the basis of positive PUAT and negative PUAT for comparison. Categorical data were expressed as frequency and percentage and continuous data as median and interquartile range (IQR). Comparisons between positive and negative PUAT groups were conducted using χ² or Fisher exact test for categorical variables and the Mann-Whitney U test for continuous variables. Last, among PUAT-positive patients, a univariate analysis was conducted to assess differences in characteristics and outcomes between patients who were
de-escalated and those patients who were not de-escalated or required escalation. All analyses were performed using SPSS version 25 software (IBM, Armonk, New York).

RESULTS

Patient Characteristics

A total of 3666 PUATs were performed during the study period resulting in 135 positive PUATs (3.7%) and 3531 negative PUATs (96.3%). Ultimately, 910 patients admitted with a primary diagnosis of CAP were included. Of those, 121 (13.3%) patients had a positive PUAT and 789 (86.7%) patients had a negative PUAT (Figure 1). Demographic and clinical characteristics of included patients are summarized in Table 1. No significant differences between groups were observed with regards to race, treating hospital, CCI, and underlying comorbidities. Distribution of PSI score was similar between groups ($P = .396$), with 64 (52.9%) PUAT-positive patients and 375 (47.5%) PUAT-negative patients presenting with moderate/high-risk disease.

PUAT testing occurred shortly after presentation to the hospital in both the PUAT-positive and -negative groups (median [IQR], 16 [16–27] hours vs 13 [8–22] hours, $P = .140$). Significantly more patients in the negative PUAT group had a Legionella urinary antigen test performed (101 [83.5%] vs 729 [92.4%], $P = .002$) with negative results, whereas no significant differences were observed between groups with respect to performance of additional diagnostic tests including MRSA/methicillin-susceptible S aureus nasal swab, sputum culture, blood culture, and influenza and respiratory viral panel.

Inpatient Antimicrobial Exposure

Exposure to antimicrobials by agent and class at any time during the admission are presented in Table 2. Azithromycin was the most frequently used agent for atypical coverage and utilization was similar between PUAT-positive and -negative groups (66.9% vs 73.4%, $P = .171$), respectively. Piperacillin-tazobactam (43% vs 37.4%, $P = .281$) and vancomycin (50.4% vs 46.4%, $P = .466$) use was common and similar between groups.

Antimicrobial-specific durations of therapy during entire admission can be found in Table 3. The median (IQR) DOT of atypical coverage was significantly shorter in the PUAT-positive group compared to the PUAT-negative group (2 [1–3] vs 3 [2–4] days, $P = .007$). No difference in MRSA coverage DOT was observed between groups (2 [1–4] vs 2 [2–4], $P = .625$). Numerically shorter $P$ aeruginosa coverage days was observed in the PUAT-positive group (3 [2–5] vs 4 [2–6], $P = .315$). Additionally, ceftriaxone DOT was significantly longer in the PUAT-positive group compared to the PUAT-negative group (median [IQR], 4 [2.5–7] vs 2 [3–4] days, $P < .001$).

Primary Outcome: Antimicrobial De-escalation Following PUAT Result

Overall, initial de-escalation was similar between the PUAT-positive and -negative groups (97/117 [82.9%] vs 629/775 [81.2%], $P = .746$) (Table 4). Patients with a positive PUAT...

---

**Figure 1.** Study population screening. *If a patient had multiple negative urinary antigen testing during different admissions, only the first one was included.

Abbreviations: MRSA, methicillin-resistant *Staphylococcus aureus*; PUAT, pneumococcal urinary antigen testing; RVP, respiratory viral panel; UAT, urinary antigen testing.
experienced a shorter median (IQR) time to de-escalation from performance of the PUAT (1 [0–2] vs 1 [1–2] days, P = .01).

Atypical coverage was initiated in 103 (85.1%) PUAT-positive and 722 (91.5%) PUAT-negative patients. Discontinuation of atypical coverage was similar between the PUAT-positive and -negative groups (77.7% vs 70.5%, P = .165). Patients with a positive PUAT had a shorter median (IQR) time to discontinuation of atypical coverage (1 [1–2] vs 2 [1–2] days, P = .04). Similarly, discontinuation of atypical coverage within 24 hours of PUAT was significantly more common among PUAT-positive patients (49/80 [61.3%] vs 240/509 [47.2%], P = .026).

MRSA coverage was initiated in 64 (52.8%) PUAT-positive and 368 (46.6%) PUAT-negative patients. Pseudomonas aeruginosa coverage was initiated in 61 (50.4%) of PUAT-positive and 368 (46.6%) of PUAT-negative patients. No differences in overall discontinuation/de-escalation nor time to discontinuation/de-escalation were observed between PUAT-positive and -negative groups. Additional characteristics of antimicrobial de-escalation can be found in Table 4.
Secondary Outcomes: Length of Stay, CDI, In-Hospital Mortality, and Readmission Rates

Among patients with a positive PUAT result, an unadjusted analysis demonstrated that patients who were de-escalated experienced significantly shorter overall hospital LOS compared to those who were not de-escalated (median, 6 [IQR, 4–10] days vs 7 days [IQR, 8–12], \( P < .001 \)). Incidence of CDI was numerically less common in patients who were de-escalated (2.1% vs 3.7%; odds ratio [OR], 0.56 [95% confidence interval [CI], .05–6.5], \( P = .535 \)). Similar findings were observed for 30-day infection-related readmission (2.1% vs 3.7%; OR, 0.56 [95% CI, .05–6.5], \( P = .535 \)). No differences in in-hospital mortality were observed (4 [4.3%] vs 3 [11.1%], \( P = .185 \)). Of note, there were no differences in patients’ characteristics representing severity of illness (eg, PSI, CCI, need for initial

### Table 2. Exposure to Antimicrobials by Agent and Class During Admission

| Antimicrobial                          | All Patients (N = 910) | Positive PUAT (n = 121) | Negative PUAT (n = 789) | \( P \) Value |
|---------------------------------------|------------------------|--------------------------|--------------------------|---------------|
| Azithromycin                          | 81 (66.9)              | 579 (73.4)               | .171                     |
| Doxycycline                           | 43 (35.5)              | 216 (27.4)               | .081                     |
| Vancomycin                            | 61 (50.4)              | 366 (46.4)               | .466                     |
| Piperacillin-tazobactam               | 52 (43.0)              | 295 (37.4)               | .281                     |
| Cefepime                              | 7 (5.8)                | 80 (10.1)                | .177                     |
| Aztreonam                             | 5 (4.1)                | 25 (3.21)                | .780                     |
| Amikacin                              | 3 (2.5)                | 45 (5.7)                 | .383                     |
| Fluoroquinolone                       | 4 (3.3)                | 12 (1.5)                 | .698                     |
| Linezolid                             | 6 (5.0)                | 5 (0.6)                  | .001                     |
| Ceftriaxone                           | 89 (73.6)              | 573 (72.6)               | .917                     |
| Ampicillin-sulbactam                  | 3 (2.5)                | 31 (3.9)                 | .599                     |
| Meropenem                             | 8 (6.6)                | 18 (2.3)                 | .018                     |
| Atypical coverage\(^a\)              | 103 (85.1)             | 722 (91.5)               | .038                     |
| MRSA coverage\(^b\)                  | 64 (52.9)              | 368 (46.6)               | .236                     |
| Pseudomonas aeruginosa coverage       | 61 (50.4)              | 368 (46.6)               | .499                     |

Data are presented as No. (%) unless otherwise stated; antimicrobial exposure was determined throughout entire admission.

Abbreviations: MRSA, methicillin-resistant Staphylococcus aureus; PUAT, pneumococcal urinary antigen test.

\(^a\)No. (%) may not add up to 121 (100%), as patients may have received multiple agents.

\(^b\)Patients may have received both azithromycin and doxycycline on different calendar days; atypical coverage reflects overall atypical agent use per patient.

### Table 3. Antimicrobial Days of Therapy During Entire Admission

| Antimicrobial                          | Positive PUAT (n = 121) | Negative PUAT (n = 789) | \( P \) Value |
|---------------------------------------|--------------------------|--------------------------|---------------|
| Azithromycin                          | 2 (1–3)                  | 3 (1–4)                  | .024          |
| Doxycycline                           | 2 (1–3)                  | 3 (2–4)                  | .027          |
| Vancomycin                            | 3 (1–4)                  | 2 (2–4)                  | .908          |
| Piperacillin-tazobactam               | 3 (2–6)                  | 4 (3–7)                  | .053          |
| Cefepime                              | 1 (1–4)                  | 1 (1–4)                  | .370          |
| Ceftriaxone                           | 4 (3–7)                  | 2 (3–4)                  | .0005         |
| Fluoroquinolone                       | 2 (1–9)                  | 2 (1–4)                  | .649          |
| Linezolid                             | 1 (1–2)                  | 2 (1–8)                  | .272          |
| Meropenem                             | 3 (1–12)                 | 5 (3–8)                  | .397          |
| Ampicillin-sulbactam                  | 1 (1–1)                  | 1 (1–2)                  | .564          |
| **Broad-spectrum days of therapy**    |                          |                          |               |
| Atypical coverage\(^a\)              | 2 (1–3)                  | 3 (2–4)                  | .007          |
| n = 103                               |                          | n = 722                  |               |
| MRSA coverage\(^b\)                  | 2 (1–4)                  | 2 (2–4)                  | .625          |
| n = 84                                |                          | n = 368                  |               |
| Pseudomonas aeruginosa coverage       | 3 (2–5)                  | 4 (2–6)                  | .315          |
| n = 61                                |                          | n = 368                  |               |

Data are presented as median (interquartile range) unless otherwise stated; Antimicrobial exposure was determined throughout entire admission and patients may have received multiple agents.

Abbreviations: MRSA, methicillin-resistant Staphylococcus aureus; PUAT, pneumococcal urinary antigen test.
intensive care unit (ICU) admission) between patients who were de-escalated and not de-escalated/required escalation (Table 5).

**DISCUSSION**

In this retrospective review of patients admitted with a primary diagnosis of CAP, universal use of PUAT resulted in earlier time to de-escalation of antimicrobials in patients with a positive test (median [IQR], 1 [0–2] day vs 1 [1–2] day, \( P = .01 \)). Time to atypical coverage discontinuation, specifically, was shorter in the PUAT-positive group, likely contributing most to the observed differences. Overall, fewer patients in the PUAT-positive group had *Legionella* urinary antigen testing performed, and although we are unable to discern provider rationale for atypical discontinuation, true coinfection confirmed by urinary antigen testing remains rare [12]. Conversely, we did not observe a difference in the discontinuation of anti-MRSA or antipseudomonal coverage. Use of MRSA (46.6%–52.9%) and pseudomonal coverage (46.6%–50.4%) in our patient population was slightly lower than in the recent study by Schimmel et al [1] that reported early antimicrobial therapy with combined anti-MRSA/antipseudomonal coverage in 53.5% of the 25 932 patients who received PUAT. In our study we observed high overall initial de-escalation rates of 82.9% in PUAT-positive patients and 81.2% of PUAT-negative patients. This is in contrast to a large database review of 159 894 patients admitted with CAP or healthcare-associated pneumonia, in which Schimmel et al describe low de-escalation rates at day 3 of therapy of 38.4% in PUAT-positive cases compared to 17% with a negative PUAT and 14.6% without PUAT performed. Of note, de-escalation

| Characteristic | Positive PUAT (n = 121) | Negative PUAT (n = 789) | \( P \) Value |
|---------------|-------------------------|-------------------------|--------------|
| Overall initial de-escalation | 97/117 (82.9) | 629/775 (81.2) | .746 |
| Time to de-escalation from PUAT, d, median (IQR) | 1 (0–2) | 1 (1–2) | .01 |
| Atypical coverage | 103 (n) | 722 (n) | .026 |
| Discontinuation | 80/103 (77.7) | 509/722 (70.5) | .165 |
| Between 24 h of PUAT | 49/80 (61.3) | 240/509 (47.2) | .026 |
| Time to discontinuation, median (IQR) | 1 (1–2) | 2 (1–2) | .04 |
| MRSA coverage | 64 (n) | 368 (n) | .228 |
| Discontinuation | 45/64 (70.3) | 265/368 (72) | .898 |
| Between 24 h of PUAT | 24/45 (53.3) | 127/265 (47.9) | .610 |
| Time to discontinuation, d, median (IQR) | 1 (1–2) | 2 (1–2) | .131 |
| *Pseudomonas aeruginosa* coverage | 61 (n) | 368 (n) | .228 |
| De-escalationa | 35/61 (57.4) | 177/368 (48.1) | .228 |
| Within 24 h of PUAT | 20/35 (57.1) | 99/177 (55.9) | .895 |
| Time to de-escalation, d, median (IQR) | 1 (1–2) | 1 (1–2) | .621 |

Data are presented as No. (%) unless otherwise stated. Abbreviations: IQR, interquartile range; MRSA, methicillin-resistant *Staphylococcus aureus*; PUAT, pneumococcal urinary antigen test.

*aDe-escalation defined as ≤3 days of therapy (discontinued within 3 days from initiation of antibiotic).*

| Characteristic | PUAT-Positive Patients (n = 121) | OR (95% CI) | \( P \) Value |
|---------------|-----------------------------|-------------|--------------|
| PSI category V | 16 (17) | 5 (18.5) | 0.91 (.276–2.74) | .856 |
| PSI, median (IQR) | 98 (74–123) | 92 (76–116) | ... | .881 |
| CCI, median (min, max) | 1 (1, 2) | 1 (1, 3) | ... | .774 |
| Age, y, median (IQR) | 72 (58–83) | 72 (63–84) | ... | .261 |
| Hospital LOS, median (IQR) | 6 (4–10) | 8 (7–12) | ... | .0005 |
| Initial ICU admission | 5 (5.3) | 2 (74) | 0.71 (.128–3.85) | .652 |
| Incidence of CDI | 2 (2.1) | 1 (3.7) | 0.56 (.05–6.48) | .535 |
| 30-d infection-related readmission | 2 (2.1) | 1 (3.7) | 0.56 (.05–6.48) | .535 |
| In-hospital mortality | 4 (4.3) | 3 (11.1) | 0.26 (.009–17) | .185 |

Data are presented as No. (%) unless otherwise stated. Abbreviations: CCI, Charlson Comorbidity Index; CDI, *Clostridioides difficile*; CI, confidence interval; ICU, intensive care unit; IQR, interquartile range; LOS, length of stay; OR, odds ratio; PSI, Pneumonia Severity Index; PUAT, pneumococcal urinary antigen test.

*aNine of 27 required escalation after 3 days of initial therapy; 18 of 27 were not de-escalated during hospital stay.*
in this study was defined as a narrowing of therapy to a single agent with activity against *S pneumoniae* [6]. Additionally, the de-escalation rates we observed were higher than the 63% observed by West et al in a review of 7 hospitals within a large healthcare system, whose definition of de-escalation included a decreased number and/or spectrum of antimicrobial activity [7]. While variability in our findings may be attributed to differences in de-escalation definitions, it is also possible that the routine use of PUAT in combination with MRSA and Legionella urinary antigen screening, antimicrobial stewardship education for house staff, and PUAT integration within the computerized physician order entry CAP admission order set have led to improved de-escalation rates. In addition to high de-escalation rates, we observed an increased usage of ceftriaxone in PUAT-positive patients, represented by significantly more DOT compared to PUAT-negative patients. These results indicate adherence to our local institutional CAP guidelines which, during the study period, recommended third-generation cephalosporin use for treatment of CAP in general but also for the treatment of *S pneumoniae* CAP specifically.

Similar to the *Legionella* urinary antigen test, which has drastically improved the diagnosis of Legionnaire’s disease, and the rapid group A *Streptococcus* test to identify streptococcal pharyngitis, PUAT has shown potential as a point-of-care microbiology tool to timely identity *S pneumoniae* and improve time to targeted therapies [13, 14]. Routine blood and sputum cultures can take days to result. In our study, PUAT was performed at a median 15.8 hours from presentation in the PUAT-positive group and 13.1 hours from presentation in the PUAT-negative group. Patients with a positive PUAT were also less likely to have antimicrobials escalated (77.7% de-escalated vs 22.3% required escalation/not de-escalated). In order to have the greatest impact, testing should be considered on all patients admitted with a diagnosis of CAP, and coordinated efforts should be made with microbiology personnel to ensure that appropriate workflows are established for timely PUAT results.

Cost-effectiveness of routine PUAT use remains unclear. Dinh et al, in a French ED, demonstrated a very low positivity rate (5.2%) over a 3-year time span, inferring an estimated potential cost savings of €8748 per year had testing not been performed. It should be noted, however, that there was no guideline for the use of PUAT in their ED population [15]. In contrast, we were able to show a higher PUAT positivity rate (13.3%) in our targeted population. As previously mentioned, the average cost of a hospital admission associated with a CAP diagnosis is $9686, compared to $16 per PUAT. Although not formally performed, increased cost savings may be inferred.

Furthermore, concerns have been raised that antimicrobial de-escalation to therapy targeting *S pneumoniae* following a positive PUAT may lead to a need for escalation of care or clinical relapse [16]. In our study, among the PUAT-positive group, unadjusted analysis showed shorter hospital LOS in patients de-escalated compared to those who were not de-escalated/required escalation without difference in *C difficile* infection, in-hospital mortality, or 30-day infection-related readmission. Clinical characteristics and baseline severity of illness including PSI class 5 determination, median PSI score, and need for initial ICU admission did not differ between patients who were de-escalated and those which required escalation or were not de-escalated, indicating that baseline severity of illness was balanced.

Our study has several limitations that should be considered. The results highlight the incidence and timing of de-escalation of antimicrobials for patients admitted to 2 large academic medical centers in the New York City metropolitan area and therefore generalizability could be hindered. Additionally, this study describes inpatient antimicrobial use in patients admitted for a diagnosis of CAP. We therefore were unable to evaluate the impact of PUAT on antimicrobial use in patients not requiring hospital admission as well as with patients with a primary diagnosis other than pneumonia. No formal cost analysis was performed; therefore, cost savings must be inferred. Due to the observational nature of the study, we were unable to describe clinical rationale for empiric or definitive therapies that patients received. Last, outcomes comparisons among PUAT-positive patients remain unadjusted and therefore provider rationales for de-escalation could be due to undetermined patient characteristics.

In conclusion, we observed in our study earlier de-escalation in patients with positive PUAT. This seems to be due to discontinuation of atypical rather than anti-MRSA or antipseudomonal coverage. Our findings support PUAT as a potential opportunity for improvement in antimicrobial use with additional stewardship interventions.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyrighted and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

**Acknowledgments.** The authors would like to thank Sadie Solomon for assistance with data mining.

**Patient consent.** This study did not include factors necessitating patient consent. The New York University Langone Health Institutional Review Board approved this study, which conforms to current standards.

**Potential conflicts of interest.** All authors: No reported conflicts of interest.

All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Jain S, Self WH, Wunderink RG; CDC EPIC Study Team. Community-acquired pneumonia requiring hospitalization. *N Engl J Med* 2015; 373:2382.
2. Peyran P, Arnold FW, Bordon J, et al. Incidence and mortality of adults hospitalized with community-acquired pneumonia according to clinical course. *Chest* 2020; 157:54–41.

Pneumococcal Urinary Antigen Testing in Patients With CAP • OFID • 7
3. Olasupo O, Xiao H, Brown JD. Relative clinical and cost burden of community-acquired pneumonia hospitalizations in older adults in the United States—a cross-sectional analysis. Vaccines (Basel) 2018; 6:59.
4. Metlay JP, Waterer GW, Long AC, et al. Diagnosis and treatment of adults with community-acquired pneumonia. an official clinical practice guideline of the American Thoracic Society and Infectious Diseases Society of America. Am J Respir Crit Care Med 2019; 200:e45–67.
5. Sinclair A, Xie X, Teitscher M, Dendukuri N. Systematic review and meta-analysis of a urine-based pneumococcal antigen test for diagnosis of community-acquired pneumonia. J Clin Microbiol 2013; 51:2303–10.
6. Schimmel JJ, Haessler S, Imrey P, et al. Pneumococcal urinary antigen testing in United States hospitals: a missed opportunity for antimicrobial stewardship. Clin Infect Dis 2020; 71:1427–34.
7. West DM, McCauley LM, Sorensen JS, et al. Pneumococcal urinary antigen test use in diagnosis and treatment of pneumonia in seven Utah hospitals. ERJ Open Res 2016; 2:00011-2016.
8. Banks R, Zappernick T, Wilson B, et al. A positive pneumococcal urinary antigen test promotes narrow-spectrum antibiotic use in patients with non-invasive pneumococcal pneumonia. Diagn Microbiol Infect Dis 2020; 96:114897.
9. Uematsu H, Hashimoto H, Iwamoto T, et al. Impact of guideline-concordant microbiological testing on outcomes of pneumonia. Int J Qual Health Care 2014; 26:100–7.
10. Costantini E, Allara E, Patrucco E, et al. Adherence to guidelines for hospitalized community-acquired pneumonia over time and its impact on health outcomes and mortality. Intern Emerg Med 2016; 11:929–40.
11. Kadri SS. A reappraisal of streptococcal urinary antigen testing for antibiotic stewardship. Clin Infect Dis 2020; 71:1435–7.
12. Beg M, Arif H, Walsh T. Community-acquired pneumonia secondary to Legionella pneumophila and Streptococcus pneumoniae: a rare co-infection. Cureus 2019; 11:e4080.
13. Yu VL. A clinical solution to antimicrobial resistance in community-acquired pneumonia: narrowing the spectrum of antimicrobial therapy: comment on “Current and potential usefulness of pneumococcal urinary antigen detection in hospitalized patients with community-acquired pneumonia to guide antimicrobial therapy”. Arch Intern Med 2011; 171:172–3.
14. Sordé R, Falco V, Lawak M, et al. Current and potential usefulness of pneumococcal urinary antigen detection in hospitalized patients with community-acquired pneumonia to guide antimicrobial therapy. Arch Intern Med 2011; 171:166–72.
15. Dinh A, Duran C, Davido B, et al. Cost effectiveness of pneumococcal urinary antigen in emergency department: a pragmatic real-life study. Intern Emerg Med 2018; 13:69–73.
16. Falguera M, Ruiz-González A, Schoenenberger JA, et al. Prospective, randomised study to compare empirical treatment versus targeted treatment on the basis of the urine antigen results in hospitalised patients with community-acquired pneumonia. Thorax 2010; 65:101–6.
17. Charlson ME, Pompeo P, Alex KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987; 40:373–83.
18. Fine MJ, AabTLE, Yealy DM, et al. A prediction rule to identify low-risk patients with community-acquired pneumonia. N Engl J Med 1997; 336:243–50.