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Incidence of Streptococcus Pneumoniae Using Urinary Antigen Test in Pneumonic Children Attending Suez Canal University Hospital

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ABSTRACT

Background: Streptococcus pneumoniae is the main etiology of bacterial pneumonia and may additionally cause invasive infections such as meningitis and sepsis, as well as non-invasive ones like sinusitis and otitis media.

Aim: To enable early detection of pneumococcal pneumonia using urinary antigen test (UAT) as a non-invasive and rapid screening tool for better management.

Patients and methods: This prospective observational research has been carried out at the Pediatric Department and PICU of Suez Canal University Hospital. It included 110 children (1 month–5 years) who were admitted with community-acquired pneumonia (CAP) based on the World Health Organization (WHO) criteria.

Results: Among 110 hospitalized children with CAP, 41 cases (37.3%) were tested positive and 69 cases (62.7%) were negative for S. pneumoniae using the UAT. This corresponds to an incidence of 373 cases per 1,000 CAP admissions during the 6-month study period. Fever, cyanosis, and prolonged capillary refill time were significantly more prevalent in UAT-positive patients (p-value below 0.05). All participants presented with tachypnea and cough as per WHO CAP criteria. UAT-positive cases had higher TLC, neutrophils, NLR, and CRP, with lower lymphocyte counts ($p < 0.001$). Lobar pneumonia was the predominant radiological finding in UAT-positive patients, while interstitial pneumonia, bronchopneumonia, and normal X-rays were more common in UAT-negative cases ($p < 0.001$). Among UAT-positive children, 70.7% were discharged, while 29.3% died.

Conclusion: S. pneumoniae was found in 37.3% of CAP cases using UAT — a quick and reliable tool that helps catch what cultures might miss and guides better treatment decisions.

Keywords: Streptococcus Pneumoniae; UAT; Children; Incidence.

INTRODUCTION

Pneumonia represents one of the main etiologies of death in pediatrics. The global yearly frequency of community-acquired pneumonia was assessed to be over 1,400 patients per 100,000 kids or one patient per seventy-one kids each year **(1).** In 2022, approximately 740,180 kids under the age five died due to pneumonia globally, in spite of the general enhancement in living conditions, improved nutrition, and availability of vaccines (2).

Streptococcus pneumonia is the most prevalent etiology of bacterial pneumonia, which can also cause a variety of invasive infections like sepsis and meningitis, as well as non-invasive mucosal infections like otitis and sinusitis media. It causes high morbidity and mortality worldwide, especially in children under 5 years of age (3).

The diagnostic tests available to validate the diagnosis of the etiology of community-acquired pneumonia are blood cultures, recognition of bacterial antigens, culture of respiratory secretions and polymerase chain reaction-based techniques. Pneumococcal pneumonia diagnosis is usually confirmed by the detection of *S. pneumoniae* in blood culture. The result of the cultures is limited by time to identification, prior antibiotics and bacterial autolysis. Additionally, blood cultures have a low diagnostic yield and provide limited certainty in improving clinical outcomes (4).

Urinary antigen detection of S. pneumoniae is an immune chromatographic test for the presence of the pneumococcal C-polysaccharide coat protein in urine and may produce outcomes within fifteen minutes of the specimen being gained and therefore it may be utilized as a rapid diagnostic test for S. pneumoniae infection in kids presenting with pneumonia (5).

The aim of this study was to enable early detection of pneumococcal pneumonia using UAT as a non-invasive and rapid screening tool for better management.

PATIENTS AND METHODS

This prospective observational research has been carried out at the Pediatric Department and PICU of Suez Canal University Hospital between May and October 2024. It included 110 children aged between 1 month and 5 years who were admitted with community-acquired pneumonia (CAP) based on the World Health Organization criteria, that involve difficulty breathing or cough along with one of the following: lower chest wall indrawing or age-specific fast breathing.

Inclusion Criteria: Kids from one month to five years of both sexes, diagnosed with CAP according to WHO criteria. Participants had signs of lower respiratory infection (cough and/or difficulty breathing, with or

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without fever), confirmed by either fast breathing or chest indrawing.

Exclusion criteria: Children with hospital-acquired pneumonia, aspiration pneumonia, known asthmatics presenting with asthma exacerbation, chronic cardiac or chest conditions, those who received pneumococcal conjugate vaccine in the past 48 hours, or patients admitted with pneumonia within the previous 3 months have been excluded from the study.

Sample size: Type of sampling: comprehensive sampling (all eligible community acquired pneumonia children presented during the study period were recruited after their approval). Sample size has been assessed utilizing the following formula [6].

$$n = \left[\frac{Z_{\alpha/2}}{E}\right]^2 * \frac{S_n(1 - S_n)}{(P)}$$

Methods

All enrolled children underwent a comprehensive clinical history and examination, focusing on symptoms such as fever, cough, dyspnea, cyanosis, grunting, and wheezes, along with vital signs assessment including temperature, respiratory rate, oxygen saturation, and oxygen therapy need. Laboratory investigations involved C-reactive protein (CRP), complete blood count (CBC), as well as radiological evaluation via chest X-ray to confirm pneumonia. Urinary antigen testing for Streptococcus pneumoniae was performed using the Biopanda test. Urine specimens were collected aseptically using a urinary catheter and placed in standard sterile containers. The sample was stored at room temperature (fifteen to thirty degrees Celsius) if evaluated within twenty-four hours of collection, or at two to eight degrees Celsius for up to fourteen days, or at minus ten degrees Celsius to minus twenty degrees Celsius for longer times prior to testing. The test procedure involved removing the test cassette from the foil pouch and using it within 1 hour, adding three full drops (approx. 120 ul) of specimen into the sample well of the test cassette vertically, and reading results at 15 minutes. A positive result, indicated by two lines (one in the test line area and one in the control line area), signified the presence of S. pneumoniae antigens. A negative result, indicated by a single line in the control line region, suggested the absence of detectable S. pneumoniae antigens. Invalid results, where the control line fails to appear, required repeating the test with a new cassette.

Statistical analysis

The study used IBM SPSS software to analyze data, focusing on qualitative data utilizing percent and number and quantitative information utilizing mean, standard deviation, median, interquartile range, as well as range. The significance of the outcomes has been judged at the five percent level. Tests utilized included Chi-square or Fisher's Exact test for categorical parameters, and Mann Whitney test for quantitative parameters as they were abnormally distributed.

Ethical consideration:

The Research Ethics Committee at Suez Canal University approved the research, while administrative approval was obtained from Suez Canal University Hospital and Pediatrics Department. Parents or legal guardians signed written consent after understanding the study's aim and procedures. Participants had the right to refuse or withdraw at any time without reason. This ensured ethical conduct and fairness in the study. The Helsinki Declaration was followed throughout the study's duration.

RESULTS

This study included 110 Children from one month to five years who were diagnosed with CAP based on WHO criteria. The children were categorized into two groups; those with pneumococcal pneumonia (UAT-positive) and those with UAT-negative results.

Figure 1 demonstrates that among 110 newly diagnosed CAP cases in this study, 41 (37.3%) were positive for Streptococcus pneumoniae using UAT. This corresponds to an incidence of 373 new cases per 1,000 hospitalized CAP cases, over the six-month study period.

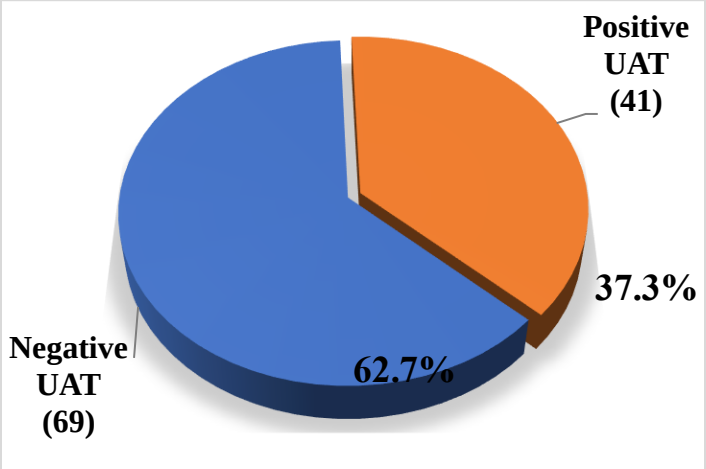

Figure 1: Percentage of S. pneumoniae in the studied sample according to Urinary Antigen Test (UAT) results (n=110).

Table 1 shows no statistically significant difference in sex or age distribution between UAT-positive and UAT-negative groups. Participants aged from 3–12 months represented the most common age group with S. pneumoniae infection, accounting for 56.1% of positive cases.

Table 1: Comparative analysis among the 2 examined groups regarding base line characteristic

Demographics	S. pneumonia UAT				Total (n = 110)		Test of Sig.	p
	Negative (n = 69)		Positive (n = 41)					
	No.	%	No.	%	No.	%		
Sex								
Male	44	63.8	22	53.7	66	60.0	χ^2= 1.095	0.295
Female	25	36.2	19	46.3	44	40.0		
Age (months)								
<3 month	10	14.5	6	14.6	16	14.5	χ^2= 2.148	0.542
3 – 12 months	33	47.8	23	56.1	56	50.9		
>12 - 36 months	20	29.0	7	17.1	27	24.5		
>36 months	6	8.7	5	12.2	11	10.0		
Mean ± SD.	15.29 ± 15.22		15.12 ± 14.68		15.58 ± 16.28		U= 1384.50	0.853

IQR: Interquartile range SD: Standard deviation U: Mann Whitney test χ^2: Chi square

Figure 2 demonstrates that fever, cyanosis, and prolonged CRT were significantly more frequent in UAT-positive individuals. Tachypnea and cough were universal among all participants, as these are part of the WHO diagnostic criteria for CAP.

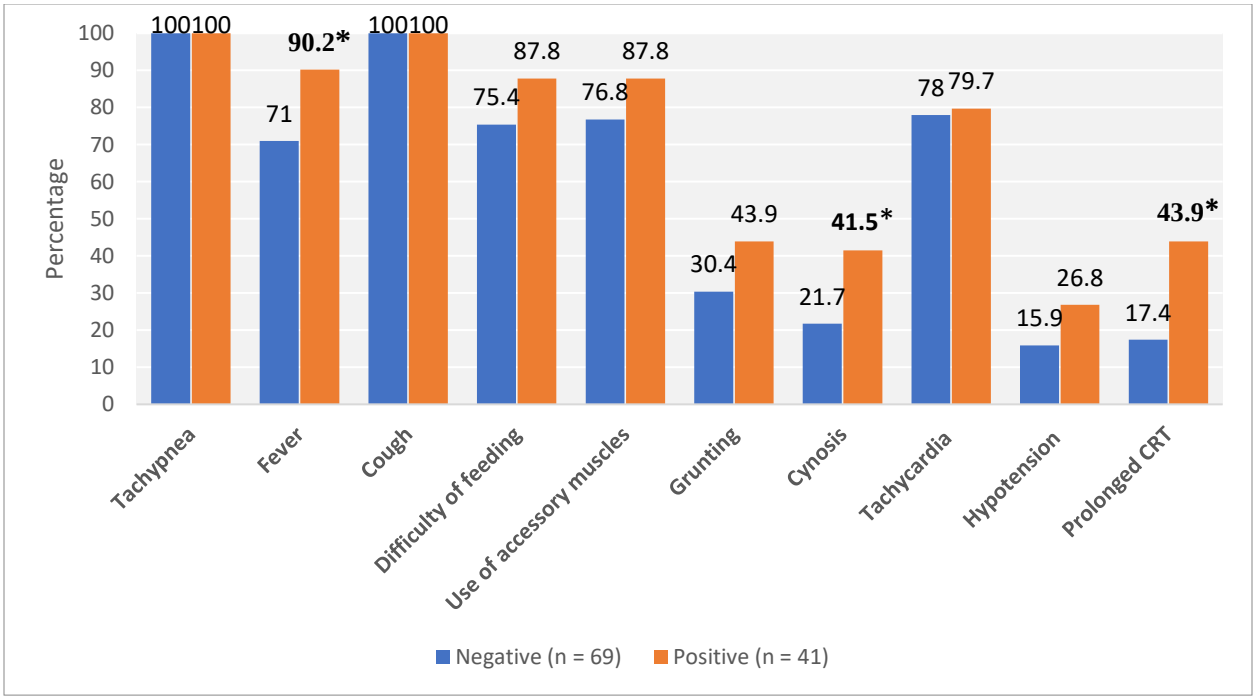

Figure 2: Comparative analysis among the 2 examined groups regarding base line characteristics.

*: Statistically significant at $p \leq 0.05$ **: Statistically significant at $P \leq 0.01$.

Table 2 shows that UAT-positive group had significantly higher mean of TLC, neutrophil count, NLR, and CRP than UAT-negative group. Additionally, the UAT-positive group had significantly lower mean of lymphocyte counts compared to the UAT-negative group.

Table 2: Comparative analysis among the 2 examined groups regarding laboratory results

Laboratory Test	S. pneumonia UAT		Total (n = 110)	Test of Sig.	p
	Negative (n = 69)	Positive (n = 41)			
TLC					
Mean ± SD.	14.13 ± 3.68	18.20 ± 4.71	15.65 ± 2.07	U= 732.00*	<0.001*
Neutrophils					
Mean ± SD.	45.84 ± 2.29	67.32 ± 10.10	53.85 ± 2.08	U= 596.00*	<0.001*
Lymphocytes					
Mean ± SD.	46.77 ± 9.56	27.22 ± 5.84	39.48 ± 8.91	U= 613.500*	<0.001*
NLR					
Mean ± SD.	1.47 ± 0.35	2.87 ± 0.55	1.99 ± 0.18	U= 629.00*	<0.001*
CRP					
Mean ± SD.	18.66 ± 1.69	75.22 ± 9.35	39.74 ± 3.26	U= 212.500*	<0.001*

TLC: Total Leukocyte Count, NLR: Neutrophil to Lymphocyte Ratio, CRP: C-reactive protein.

Figure 3 shows that lobar pneumonia was the most significant radiological feature associated with UAT-positive group. In contrast, interstitial pneumonia, normal chest X-ray (CXR) findings, and bronchopneumonia were more frequently observed in the UAT-negative group, possibly indicating non-S. pneumoniae infections or other etiologies. The noticed variances among the groups were statistically significant, with a p-value of < 0.001.

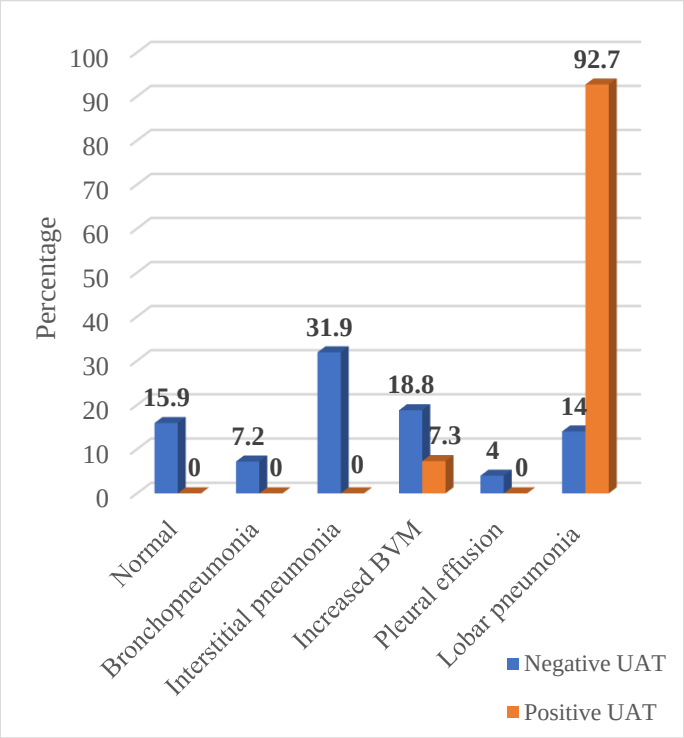

Figure 3: Comparative analysis among the 2 examined groups regarding chest X-ray (CXR) findings.

Table 3 presents the outcomes of the UAT-positive group, showing that 70.7% of patients were discharged.

Table 3: Outcome of the studied UAT- positive group

Outcome	Frequency	Percentage
Discharge	29	70.7%
Death	12	29.3%

DISCUSSION

Pneumonia is a main etiology of death and morbidity in kids under five, especially in developing countries. Streptococcus pneumoniae is the main pathogen of CAP in children worldwide [7].

This study is prospective observational research to estimate the frequency of S. pneumoniae using UAT. The study included 110 children with CAP who came to Suez Canal University Hospital between May and October 2024, representing a seasonal variation study.

Our study reveals a significant percentage of pneumococcal pneumonia, with the UAT being positive in 37.3%, nearly one-third of the participants enrolled in this study. This corresponds to an incidence of 373 new cases per 1,000 hospitalized CAP cases over the six-month study period.

Most researches of the causative agents of community-acquired pneumonia in kids are restricted by difficulty gaining suitable samples [8] .

Numerous researches have examined the causative agents of community-acquired pneumonia. In Egypt, **Hussein *et al.*** [9] reported that the most commonly detected bacterial pathogen among Egyptian children was S. pneumoniae (23.3 percent), followed by Staphylococcus aureus (16.7 percent).

Our study found that most of the UAT positive patients were in the age group of 3 months – 12 months, accounting for 56.1% of the UAT positive cases. This can be explained by the fact that young kids and newborns are more vulnerable to pneumonia due to their immature immune systems.

Chen *et al.* [10] found that subtle symptoms in infants can delay early diagnosis and appropriate treatment, leading to severe illness.

In our study, most of the UAT positive cases were males (53.7%). A higher prevalence of males was also observed in the research population, in agreement with findings from other researches [11].

Regarding signs of morbidity, UAT positive cases showed more tachycardia, hypotension, prolonged capillary refill time, and cyanosis, progressing to septic shock. These outcomes are in agreement with those of **Fu *et al.*** [12] who reported that S. pneumoniae causes severe clinical manifestations and morbidity, with 34.27% of patients diagnosed with sepsis.

In our study, both the UAT-positive and UAT-negative patients were diagnosed with cough and tachypnea. However, fever, grunting, feeding difficulty, and cyanosis were the most prevalently stated symptoms in the UAT-positive patients. Similarly, **Zedan *et al.*** [13] reported that respiratory distress (one hundred percent), fever (87.4%), as well as cough (100%) were the three most frequently reported symptoms among CAP cases in the Delta area of Egypt.

Regarding laboratory findings, UAT-positive patients had significantly higher mean TLC (18.20 ± 4.71 vs. 14.13 ± 4.68) and higher CRP (75.22 ± 39.35 vs. 18.66 ± 18.69) with a p-value <0.001. This is in agreement with research by **Wrotek *et al.*** [14], who found that serum inflammatory markers were associated with confirmed bacterial pneumonia and negatively correlated with viral and atypical pneumonia.

Additionally, **Barak-Corren *et al.*** [15] reported that a CRP level > 20 mg/dL has been correlated with severe bacterial pneumonia, as indicated by the need for hospitalization, longer stays, parapneumonic effusion, chest drains, and PICU admission.

Also, in our study, we found that UAT-positive patients had higher neutrophil counts (67.32 ± 10.10 vs. 45.84 ± 20.29) and higher NLR (2.87 ± 1.55 vs. 1.47 ± 1.35) with a p-value <0.001. These findings are consistent with those of **Che-Morales and Cortes-Telles** [16], who demonstrated that higher NLR values are associated with increased pneumonia severity. Similarly, **Zheng *et al.*** [17] reported a mean NLR value of 2.13±1.32, which has been correlated with worse clinical results in kids with severe bacterial pneumonia.

In this research, imaging differences were statistically significant between the two groups, with lobar pneumonia predominantly observed in 92.7% of UAT-positive cases, compared to 20.3% in the UAT negative cases. These findings align with **Mani** [18], which reported that lobar pneumonia is most frequently (90%–95%) caused by S. pneumoniae.

Pneumococcal pneumonia has been correlated with a more severe clinical presentation and greater death. As in our study, mortality rate was higher in the group with a positive UAT (29.3%) compared to the negative group (13.0%) with statistically significant variances as p was below 0.05. Also, a high mortality rate caused by S. pneumoniae has been reported in other studies, as shown by **Versluys *et al.*** [19] who reported 408 cases of invasive pneumococcal disease, resulting in 49 deaths (5.5%), of which 17 (34.7%) were linked to pneumonia.

CONCLUSION

Our study highlights a significant burden of pneumococcal pneumonia, with *S. pneumoniae* detected by UAT in 37.3% of cases, corresponding to an incidence of 373 per 1,000 hospitalized CAP cases. Culture-based diagnosis may miss cases, especially with antibiotic misuse. UAT is a valuable point-of-care tool for rapid screening, improving patient care and antibiotic stewardship.

RECOMMENDATION

The pneumococcal UAT is a rapid, accurate, and non-invasive screening instrument that enhances diagnostic accuracy, facilitates early detection, and reduces complications. It is also recommended to include pneumococcal vaccines in the Egyptian compulsory immunization schedule to prevent serious infections.

DECLARATIONS

- **Consent for publication:** I certify that each author has granted permission for the work to be submitted.
- **Funding:** No fund
- **Availability of data and material:** Available
- **Conflicts of interest:** None
- **Competing interests:** None

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