Observational Study

Medicine

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Impact of FilmArray respiratory panel test for hospitalized pediatric respiratory tract infection in Taiwan

A 3-year single-center cohort study

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Abstract

Respiratory tract infections are prevalent and clinically significant in pediatric populations globally. However, pathogen testing often involves time-consuming processes, resulting in delays in diagnosis. To date, commercial testing machines, such as the FilmArray respiratory panel, have been proposed for hospitals. Therefore, this study aimed to investigate the impact of the FilmArray respiratory panel at a single center. This study utilized the medical records of our hospital to select pediatric inpatients with respiratory tract infections who underwent the FilmArray respiratory panel between September 2020 and April 2021 and those who did not undergo nucleic acid detection (a rapid test group) between September 2019 and April 2020. FilmArray is a polymerase chain reaction-based diagnostic tool. The FilmArray respiratory panel group was scheduled to recruit 150 patients (final 137 patients), whereas the rapid test group was scheduled to recruit 300 patients (final 267 patients). Differences in continuous variables between the 2 groups were analyzed using independent Student *t* tests. The FilmArray respiratory panel group had a longer length of inpatient days, longer duration of antibiotic use, and higher proportion of pathogens that tested positive, with significant differences than those in the rapid test group. Fever duration showed no significant difference between the 2 groups. For the polymerase chain reaction method, respiratory syncytial virus was the most commonly detected pathogen causing pneumonia, followed by human rhinovirus/enterovirus and parainfluenza virus. *Mycoplasma* was detected using the rapid test but not with the FilmArray respiratory panel. The FilmArray respiratory panel provides clinicians with a rapid and useful diagnostic tool. The effect was quite good for virus detection, but not for bacteria. Given its limited adoption, the tool may not aid clinicians in the diagnosis of mild cases.

Abbreviations: PCR = polymerase chain reaction, RSV = respiratory syncytial virus, RTIs = respiratory tract infections, URIs = upper respiratory tract infections.

Keywords: FilmArray respiratory panel, PCR, respiratory tract infections

1. Introduction

Respiratory tract infections (RTIs) are a common and important disease in pediatric patients worldwide.[1] The severity of the disease varies widely, from mild disease needing medication treatment to severe disease, including pneumonia, resulting in hospitalization. RTIs are caused by a wide variety of pathogens, including viruses and bacteria. The common viruses are rhinovirus, adenovirus, coronavirus, influenza virus, and parainfluenza virus.[2] In addition, the common bacteria are *Streptococcus pneumoniae*,[3] *Haemophilus*,[4] and *Mycoplasma*.[5] Previously, pathogens testing[6] had an inherent lag because of the necessary time and cumbersome steps for various testing items for different types of pathogens such as serum antibodies,[7] and antigen rapid screening.[8] Recent advancements have been made in the multiplex polymerase chain reaction (PCR)-based assay.[9] To date, several commercial testing machines have been proposed and fairly reliable results can be obtained within a certain period of time. Commercial testing machines[10] can be used by clinicians to evaluate patients' condition, which has an extremely high utilization value. Following

This research was funded by the Taiwan Adventist Hospital (grant number: TAH-110-MR-7).

The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the Taiwan Adventist Hospital (110-E-07).

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How to cite this article: Hu J-J, Wang D-L, Tzeng I-S. Impact of FilmArray respiratory panel test for hospitalized pediatric respiratory tract infection in Taiwan: A 3-year single-center cohort study. Medicine 2024;103:13(e37320).

Received: 3 August 2023 / Received in final form: 20 December 2023 / Accepted: 30 January 2024

http://dx.doi.org/10.1097/MD.0000000000037320

the adoption of the FilmArray respiratory panel[11] by our hospital for inpatient use in September 2020, this nucleic acid detection module provided a high reference value for disease assessment and treatment for RTI diagnosed in the pediatric department of our hospital. A previous study in Japan highlighted that this test can reduce the usage of antibiotics and number of hospitalization days from a clinical perspective.[12] Such studies can provide more clinical data in the hospital setting for reference in the formulation of subsequent SOP-related policies.[12] Therefore, the aim of the present study was to retrospectively investigate the impact of the FilmArray respiratory panel at a single center compared to that of a rapid test based on assessments of various indicators of patients' condition.

2. Methods

2.1. Test methods and procedures

This study utilized the medical records of our hospital to select pediatric inpatients with RTI who underwent the FilmArray respiratory panel between September 2020 and April 2021, and the rapid test group who did not use nucleic acid detection between September 2019 and April 2020 for RTI pediatric inpatients. The discharge diagnosis code was used as the inclusion criterion. Patients with non-RTI diagnostic codes were excluded. The FilmArray respiratory panel group was scheduled to recruit 150 patients, and the rapid test group was scheduled to recruit 300 participants. Characteristics of the inpatients recruited in the retrospective study included sex, age, diagnosis, symptoms, length of hospital stay, imaging data, whether antibiotics were used and the type and length of days, and laboratory test results (leukocytes, C-reactive protein, culture results, various rapid screening tests, examination results, and serum antibody analysis). We compared the distribution of basic characteristics between the 2 groups (FilmArray respiratory panel group vs rapid test group) using descriptive analysis, clinical course, laboratory test results, and statistical analysis of pathogens and investigated the difference in days of antibiotic use and hospitalization.

2.2. Statistical analysis

Continuous variables are expressed as the means ± standard deviation, and categorical values are expressed in percentages. Differences between the FilmArray respiratory panel and rapid test groups for continuous variables were analyzed using the independent Student *t* test. The chi-squared test was used for categorical variables. Statistical significance was set at $P < .05$.

Table 1

General characteristics of the study groups.

Characteristics	FilmArray respiratory panel group Group (n = 137)	Rapid test group (n = 267)	*P* value
Age (mo)	34.72 ± 31.07	53.36 ± 44.24	<.001
Sex (male)	82 (59.85%)	140 (52.43%)	.1891
WBC	9755.88 ± 4885.12	9753.23 ± 5002.97	.996
CRP	2.20 ± 3.66	2.21 ± 3.16	.978
Diagnosis			
Pneumonia	75 (54.7%)	89 (33.3%)	<.001
Bronchitis	41 (29.9%)	101 (37.8%)	.115
URI	14 (10.2%)	74 (27.7%)	<.001
Other	7 (5.2%)	3 (1.2%)	.015

CRP = C-reactive protein, URI = upper respiratory tract infection, WBC = white blood cell.

All statistical tests were performed using the Statistical Package for the Social Sciences (SPSS, version 22.0) for Windows (SPSS Inc., Chicago, IL, USA).

3. Results

The basic characteristics of the 2 groups are summarized in Table 1. The patients in the FilmArray respiratory panel group were young. In the FilmArray respiratory panel group, pneumonia was diagnosed in 54.7% of cases. The majority of diagnoses in the rapid test group were upper respiratory tract infections (URIs). The remaining basic characteristics, including sex and test results (leukocyte and C-reactive protein), showed no significant differences between the 2 groups.

Table 2 presents a comparison of the clinical results of the 2 groups. The FilmArray respiratory panel group had a longer length of inpatient days, longer duration of antibiotic use, and higher proportion of pathogens that tested positive, than the rapid test group and these differences were significant ($P < .001$). Fever duration showed no significant difference between the 2 groups.

Figure 1 shows the distribution of pathogens in the rapid test group. We found that *Mycoplasma* was the dominant pathogen. Influenza A was ranked second followed by adenovirus. Figure 2 shows the distribution of pathogens in the FilmArray respiratory panel group. Respiratory syncytial virus (RSV) accounted for the majority of cases. Human rhinovirus/enterovirus ranked second, with parainfluenza virus ranked third.

In addition, in the FilmArray respiratory panel group, only 1, 2, and no pathogen was detected (positive) in the tested samples (n = 88, n = 24, and n = 25, respectively).

Table 3 lists the distribution of pathogens among the several diagnoses in the rapid test group. *Mycoplasma* was the primary cause of pneumonia. Bronchitis was mostly caused by influenza A virus or *Mycoplasma*. In URI, the main factor was influenza A. Table 4 lists the distribution of pathogens among several diagnoses in the FilmArray respiratory panel group. Considering the PCR method, RSV accounted for most of the pneumonia cases, followed by human rhinovirus/enterovirus and parainfluenza virus. *Mycoplasma* was detected using the rapid test; however, it was not detected using the FilmArray respiratory panel method.

4. Discussion

The results of this study showed that patients in the FilmArray respiratory panel group had a long hospital stay and increased antibiotic use; however, a previous study showed a decreased hospital length of stay with PCR testing.[13] We speculate that a possible explanation is that the FilmArray respiratory panel is much more expensive[14] than a general rapid screening test. This leads doctors to use the FilmArray respiratory panel only for patients with very severe pneumonia.[15] Patients with severe pneumonia were younger, and the length of hospitalization

Table 2

Main outcomes of the FilmArray respiratory panel and rapid test groups.

Variables	FilmArray respiratory panel Group (n = 137)	Rapid test group (n = 267)	*P* value
Length of inpatient d	3.96 ± 1.99	3.18 ± 1.47	<.001
Antibiotics d	2.47 ± 0.38	1.50 ± 0.23	<.001
Fever duration	1.40 ± 1.45	1.52 ± 1.24	.409
Pathogen detection	81.8%	50.6%	<.001

and antibiotic use time were longer than that in other patients with pneumonia.[16] The FilmArray respiratory panel was designed to detect 4 types of bacteria (*Bordetella parapertussis*, *Bordetella pertussis*, *Chlamydophila pneumoniae*, and *Mycoplasma pneumoniae*), which are relatively rare in children. Nasopharyngeal swabs were used to obtain specimens from the nasopharyngeal area. This area belongs to the scope of the URIs. URIs in children are mainly caused by viruses, and bacteria are uncommon. Among these 4 types of bacteria, *Mycoplasma* spp. are the most likely to cause infections in children. Blood *Mycoplasma* antibody test results were positive; however, the FilmArray respiratory panel did not detect it. We attribute this result to the limitations of the study design and methodology.

Furthermore, RSV is the most frequently detected pathogen in the FilmArray respiratory panel group,[17] and RSV is a fairly common source of infection in young patients.[17] In terms of disease, RSV is also the most commonly detected pathogen in lower RTIs.[18] Mixed bacterial infections are common among RSV infections.[19,20] Therefore, antibiotics are often used clinically in this group of patients.[21] In the rapid test group, only a few RSV tests were used.[22] In lower RTIs, the positivity rate was approximately 30%,[23] followed by *Mycoplasma*.

Mycoplasma was not detected in the FilmArray respiratory panel group but was still detected simultaneously with the rapid test for *Mycoplasma* IgM[24] in the same patient. The detection rate of samples taken from the nasopharynx was low when used for PCR detection of *Mycoplasma*.[25] Thus, *Mycoplasma* infection should be better diagnosed by a rapid test for *Mycoplasma* IgM. To the best of our knowledge, the IgM diagnostic method may not be considered an acute infection.[26]

In 2020, the COVID-19 epidemic had already spread, and the number of influenza cases in the year had mostly decreased.[27] This study showed that although present, influenza was not detected in the FilmArray respiratory panel group.

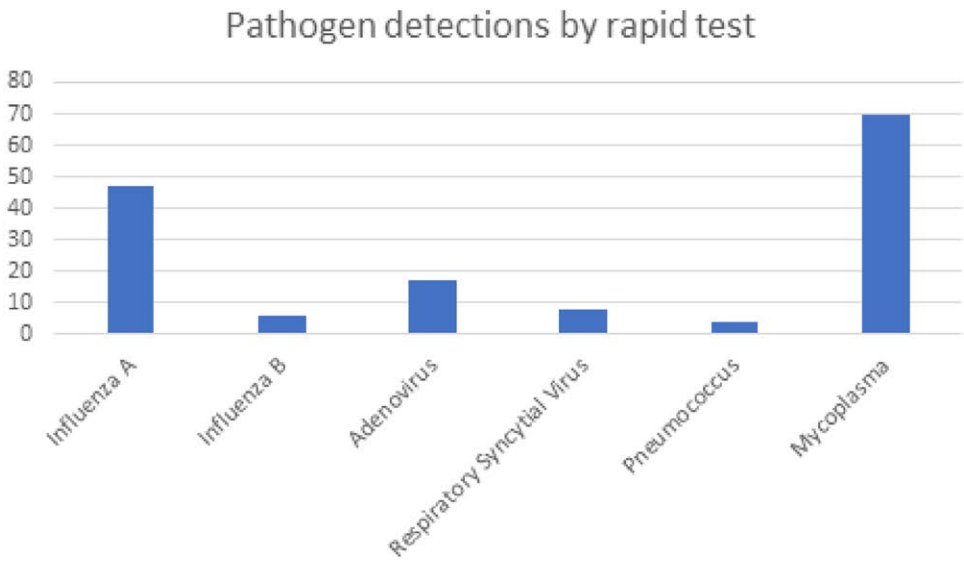

Figure 1. Pathogen distribution in the rapid test group (n = 267).

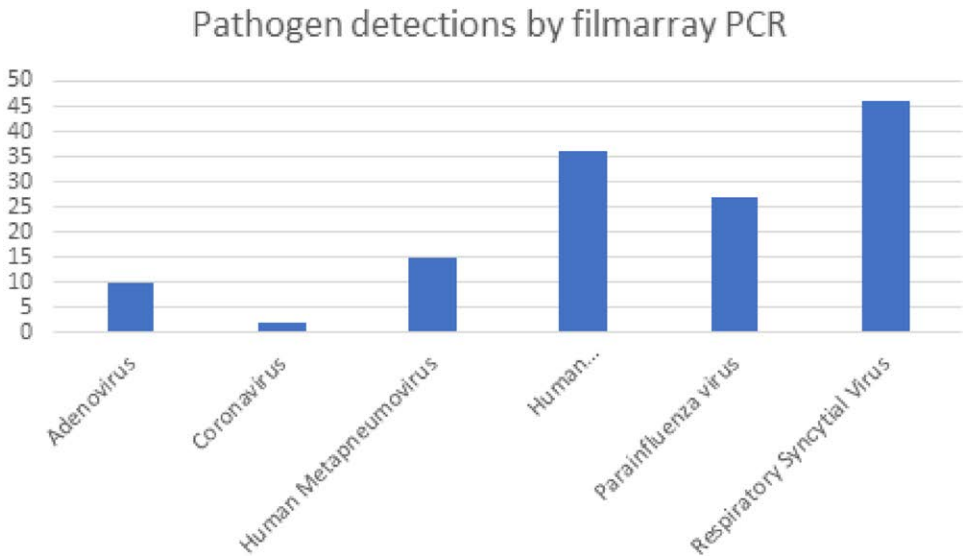

Figure 2. Pathogen distribution in the FilmArray PCR group (n = 137). PCR = polymerase chain reaction.

Table 3

Pathogens in the different diagnoses of the rapid test group.

Rapid test group (n = 267)	Pneumonia (n = 89)	Bronchitis (n = 101)	URI (n = 74)	Other (n = 3)
Influenza A				
Positive	5	16	25	1
Negative	64	49	37	1
Influenza B				
Positive	–	2	4	–
Negative	70	63	58	2
Adenovirus				
Positive	5	6	6	–
Negative	40	25	14	–
RSV				
Positive	3	5	–	–
Negative	9	15	1	1
Mycoplasma				
Positive	40	27	3	–
Negative	39	28	1	1
Pneumococcus				
Positive	4	–	–	–
Negative	45	1	–	–

RSV = respiratory syncytial virus, URI = upper respiratory tract infection.

Table 4

Pathogens identified in the different diagnoses of the FilmArray respiratory panel and rapid test groups during the same period.

	Pneumonia	Bronchitis	URI	Other
FilmArray respiratory panel group				
Adenovirus	5	4	1	–
Parainfluenza	17	6	1	3
RSV	28	15	2	1
Human Rhinovirus/Enterovirus	21	10	3	2
Human Metapneumovirus	13	2	–	–
Coronavirus	–	1	1	–
Rapid test group				
Mycoplasma (n = 57)	11	5	–	1
Pneumococcus (n = 60)	14	–	–	–

RSV = respiratory syncytial virus, URI = upper respiratory tract infection.

5. Conclusions

The FilmArray respiratory panel provides clinicians with a rapid and useful diagnostic tool. The effect was quite good for virus detection, but not for bacteria. Owing to the high cost, the method is only used in inpatients, which is helpful for clinical diagnosis. We attribute this to a lack of popularity; it cannot assist clinicians in the diagnosis of patients with mild disease. We anticipate that once the price declines, it will be used more widely by the general patient population.

Author contributions

Conceptualization: Jen-Jan Hu.
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