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ORIGINAL RESEARCH

# Exploring the efficacy of interferon nebulization combined with immunoglobulin in the treatment of adenovirus pneumonia in children

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## Abstract

**Background**: This study explores the efficacy of interferon nebulization combined with immunoglobulin in treating adenovirus pneumonia in children. **Methods**: Based on existing case records, a retrospective analysis was conducted on the clinical data of 100 pediatric patients with adenovirus pneumonia treated in our hospital from August 2020 to August 2023. According to the recorded different treatment methods, this study included 50 cases in the observation group (receiving interferon nebulization combined with immunoglobulin treatment) and 50 cases in the control group (receiving interferon nebulization treatment). Comparing the effects of the two treatment methods on the children's efficacy. **Results**: The total effective rate in the observation group was significantly higher than that in the control group, with a lower inefficacy rate ($\chi^2$ = 5.263, $p$ = 0.022 $<$ 0.05). After treatment, the clinical indicators in the observation group, including the disappearance times of cough, fever, sputum production, and lung rales, were shorter than those in the control group ($t$ = 16.159, $p < 0.001$; $t$ = 23.804, $p < 0.001$; $t$ = 17.247, $p < 0.001$; $t$ = 28.159, $p < 0.001$). Before treatment, there was no significant difference in the levels of inflammatory factors (White Blood Cell (WBC), C-Reactive Protein (CRP)) between the observation and the control groups ($t >$ 0.05); seven days after treatment, the levels of WBC and CRP in the observation group were lower than the control group ($t$ = 12.082, $p < 0.001$; $t$ = 8.828, $p < 0.001$). The incidence of complications in the observation group was lower than in the control group ($\chi^2$ = 4.000, $p$ = 0.046 $<$ 0.05). **Conclusions**: Interferon nebulization combined with immunoglobulin demonstrates significant clinical efficacy in children with adenovirus pneumonia, rapidly alleviating clinical symptoms, reducing inflammatory response, improving immune function, and ensuring high safety, worth of promoting in clinical practice.

## Keywords

Interferon; Immunoglobulin; Children's adenovirus pneumonia; Efficacy; Inflammatory factors

## 1. Introduction

Adenovirus pneumonia is a respiratory infection that primarily impacts infants and young children, posing as one of the most critical forms of pneumonia in the pediatric population [1]. From a clinical perspective, adenoviruses are responsible for around 4% to 10% of pneumonia cases. Common symptoms associated with adenovirus pneumonia comprise prolonged high fever, cough, wheezing, shortness of breath, and respiratory distress [2]. Due to the low immunity in children, the disease can easily progress to severe cases, potentially causing damage to the digestive, nervous, circulatory, and respiratory system, and even becoming life-threatening. This severity has made adenovirus pneumonia a growing focus of clinical attention [3]. Current pharmaceutical treatments lack standardization, often involving antiviral, anti-inflammatory, and symptomatic approaches, but they have not achieved ideal clinical outcomes. Ribavirin, cidofovir and ganciclovir are frequently utilized antiviral medications for managing adenovirus pneumonia; however, their efficacy in clinical settings has been suboptimal [4]. Studies have indicated decreased immunoglobulin levels in pneumonia patients [5]. Immunoglobulin, a passive immune product that includes antibodies targeting diverse microorganisms, is commonly utilized in clinical settings to address immune deficiencies like immunoglobulin deficiency, thus enhancing effectiveness to a certain degree [6]. In recent years, interferon has emerged as an effective drug in the clinical treatment of viral pneumonia. Interferon, with its broad-spectrum antiviral properties, stimulates host cells


  

to generate defense mechanisms upon viral invasion, helping bolster cellular resistance to viral infections and exhibiting efficacy against a wide range of diseases [7]. However, the efficacy of interferon alone in treating adenovirus pneumonia is limited, necessitating more effective treatment options. From a clinical perspective, it is common to combine interferon with other drugs in order to enhance treatment effectiveness. However, there is a scarcity of research on the use of interferon in conjunction with immunoglobulin for the treatment of pediatric adenovirus pneumonia C-reactive protein (CRP) is an acute-phase protein that typically increases during infection or inflammation. Increased levels of white blood cells (WBC), especially neutrophils, may suggest the presence of an infection. These markers play a crucial role in aiding doctors in the identification of adenovirus pneumonia and evaluating its seriousness. Thus, the research focuses on assessing the effectiveness of combining immunoglobulin with interferon nebulization in the treatment of adenovirus pneumonia in children and its influence on inflammatory markers (WBC, CRP) in the young patients. The goal is to provide a reference for promoting recovery and improving prognosis in pediatric patients, and to offer a basis for the rational clinical use of these drugs.

## 2. Materials and methods

### 2.1 General information

The clinical data of 100 children with adenovirus pneumonia who were treated in our hospital were retrospectively reviewed from existing case records. The study population was divided into two groups based on the treatment methods recorded: an observation group with 50 cases and a control group with 50 cases.

Inclusion Criteria: (1) Met the diagnostic criteria for pediatric adenovirus pneumonia [8], and tested positive for adenovirus nucleic acid in sputum or throat swab samples, with chest X-ray or Computerized tomography (CT) scan showing patchy shadows; (2) Exhibited symptoms such as cough, fever, wheezing, and difficulty breathing at the time of enrollment; (3) Aged between 0–6 years; (4) First onset of the disease, with no use of immunosuppressants or antiviral treatments within the 3 months prior to enrollment; (5) Had a complete medical history; (6) Met the indications for nebulized inhalation therapy (no airway malformations).

Exclusion Criteria: (1) Allergic reactions to the drugs used in this study; (2) Concurrent other infectious diseases (*e.g.*, bacterial infection, congenital syphilis); (3) Concurrent coagulation disorders, liver and kidney dysfunction, severe malnutrition, central nervous system dysfunction, congenital and hereditary lung diseases; (4) Other potential immunodeficiency diseases; (5) Poor treatment compliance or withdrawal from the study midway.

### 2.2 Methods

As a retrospective study, the intervention methods were documented in existing case records.

(1) Patient selection

Based on previous studies, it was hypothesized that the complication rate in the observation group could be reduced by 30%. Assuming a test level of 0.05 and a test power of 0.8, each group was expected to need 43 patients. Considering a 15% dropout rate, it was estimated that 50 patients were needed in each group, totaling 100 patients for the study.

(2) Treatment plan

Upon admission, both groups underwent blood tests, chest CT scans, X-rays, and clinical data analysis. Treatment strategies were implemented to address symptoms such as sticky sputum, hypoxia, and oliguria. These included actions such as suctioning and nebulization to clear the airways, ensuring electrolyte balance, and utilizing mechanical ventilation as needed. Fundamental care practices included maintaining a humidity level of 60% and a temperature of 26 °C, promoting proper air circulation, regularly repositioning the patient, utilizing back patting techniques, and offering easily digestible food [9, 10].

Control Group: Based on this, the control group received nebulized inhalation therapy with recombinant human interferon for injection (rhIFN-$\alpha$2b) (Anhui Anke Biotechnology Co. Ltd, Hefei, Anhui, China, S20000013) at a dose of 200,000 to 400,000 IU/kg, twice daily. This was added to terbutaline sulfate nebulizer solution (AstraZeneca, Sydney, NSW, Australia, JX20180163) and ipratropium bromide solution (Boehringer Ingelheim Pharma GmbH&CO.KG, Ingelheim am Rhein, RP, Germany, H20150159). The three medications were administered through oxygen-powered atomization inhalation. Nebulization treatments were scheduled either in the morning or in the evening, with timing tailored to suit the patient's condition and tolerance level. Each inhalation session typically spanned 15–20 minutes until all the medication had been effectively nebulized, utilizing a specialized compressed air nebulizer (PARY BOY Nebulizer, PARI GmbH, Starnberg, BY, Germany) to guarantee equipment cleanliness and optimal functionality. During nebulization, patients should remain calm and avoid vigorous activities.

Observation Group: In addition to the treatment provided to the control group, the observation group received intravenous gamma globulin (Sichuan Yuanda Shuyang Pharmaceutical Co. Ltd. 2.5 g/bottle, Chengdu, Sichuan, China, S10980026) at a dose of 1 g/(kg·d) continuously for 2 days. The infusion started at 1.0 mL/min initially, and if no adverse effects were observed within 15 minutes, the rate could be slowly raised, ensuring it did not exceed 3.0 mL/min. The duration of administration typically ranged from 2 to 4 hours, varying based on both the infusion rate and the patient's individual tolerance level. Healthcare professionals vigilantly monitored the patient's reaction to the medication, promptly managing any unfavorable responses. Both groups were treated according to their actual conditions for 5–7 days.

Specific instructions for medical personnel:

1. Monitoring: Regularly monitor the patient's vital signs, such as heart rate, blood pressure, respiratory rate, and oxygen saturation, to assess the effectiveness of the treatment.

2. Adverse Reaction Management: Educate medical personnel to recognize possible adverse reactions caused by interferon and immunoglobulin, such as allergic reactions, fever, and headache, and to handle them promptly.

3. Patient Education: Explain the treatment plan, possible side effects, and their management measures to the patient's

family to improve treatment compliance and safety.

These plans should be adjusted according to the specific clinical condition of the patient and the doctor's guidance to ensure the effectiveness and safety of the treatment.

(3) Data collection and analysis

After the children are admitted to the hospital, basic information such as age, gender, duration of illness, weight, admission time, and previous treatment plans (if any, record the proportion of these children) are collected. Clinical manifestations of the children are observed, including fever, runny nose, cough, shortness of breath, cyanosis around the lips, choking while feeding, drooling, inspiratory chest retractions, pulmonary rales, and wheezing. Chest X-ray findings are documented. Before treatment and on the seventh day post-treatment, 2 mL of peripheral venous blood is obtained from fasting children in the morning to assess inflammatory factor levels. The clinical manifestations and overall status of the children are evaluated and documented after 7 days of therapy to evaluate effectiveness, specifically focusing on the time taken for clinical indicators to improve in the children. Adverse reactions during hospitalization are recorded, including fever, chills, tachycardia, rash, injection site infection, induration and bleeding.

The collected data are analyzed using SPSS 21.0 statistical analysis software (IBM, Armonk, NY, USA) and GraphPad Prism 8.0.2 software (GraphPad Software Inc., San Diego, CA, USA). Normally distributed measurement data are expressed as mean ± standard deviation (SD), and inter-group comparisons are performed using the independent sample *t*-test; intra-group comparisons are performed using the paired sample *t*-test. For non-normally distributed data or data with unequal variances, the Mann-Whitney U test is used and expressed as median (M) and interquartile range (M (P25, P75)). Count data are expressed as numbers and percentages (%), and inter-group comparisons are performed using the chi-square test or Fisher's exact test; $p < 0.05$ indicates statistical significance.

### 2.3 Observation indicators

As a retrospective study, the outcome indicators have been recorded in existing case records.

(1) Clinical Efficacy: Based on the assessment standards for effectiveness outlined in the relevant literature, the enhancement of children's symptoms is assessed holistically. Evaluation of the effectiveness after a week of treatment yielded the following results: Cured: X-ray examinations showed complete absorption of inflammatory lesions, disappearance of rales and cough, and normalization of body temperature. Effective: X-ray examinations showed that most of the inflammatory lesions were absorbed, rales and cough were alleviated, and low-grade fever or normalization of body temperature was observed. Ineffective: No relief or worsening of signs and symptoms [11]. Total effective rate = (cured + effective)/total cases × 100%. (2) Clinical Indicators: Observation of the disappearance times of symptoms such as cough, fever, sputum production, and pulmonary rales. (3) Inflammatory Marker Levels: These included WBC and CRP. In the morning before any treatment, 2 mL of peripheral venous blood is drawn from the children on an empty stomach. Similarly, blood samples are also collected on the seventh day following the treatment. The collected blood samples are then centrifuged at 4000 r/min for 10 minutes using a centrifuge radius of 6 cm to separate the serum. The serum CRP levels in each group are measured using a double-antibody sandwich enzyme-linked immunosorbent assay, with kits purchased from Shanghai Hengyuan Co., Ltd. (Shanghai, China, HB2272-Hu) following the kit instructions strictly. WBC is measured using an automated analyzer. (4) Adverse Reactions: The occurrence of diarrhea, rash, mild vomiting, and exacerbation of asthma during hospitalization is recorded.

## 3. Results

### 3.1 General information

In the observation group, there were 28 males and 22 females, aged 1.25 ± 0.26 (0.5–4.1) years, and the course of disease was 6.08 ± 1.15 (4.0–8.2) days. In the control group, there were 25 males and 25 females, aged 1.28 ± 0.31 (0.5–4.2) years, and the course of disease was 5.95 ± 0.86 (4.1–7.7) days. The data of the two groups were comparable ($p > 0.05$).

### 3.2 Comparison of treatment efficacy

The total effective rate in the observation group was significantly higher than that in the control group and the inefficacy rate was lower than that of the control group ($\chi^2 = 5.263$, $p = 0.022 < 0.05$), suggesting that combining interferon with nebulization yielded superior effectiveness when compared to using interferon alone alongside nebulization (Table 1).

### 3.3 Comparison of clinical indicators

Following the intervention, it was observed that the clinical parameters in the treatment group (including the duration of cough, fever, sputum production, and lung rales) were significantly reduced compared to the control group ($t = 16.159$, $p < 0.001$; $t = 23.804$, $p < 0.001$; $t = 17.247$, $p < 0.001$; $t = 28.159$, $p < 0.001$), (Table 2).

### 3.4 Inflammatory marker levels

Before treatment, the inflammatory factor levels (WBC, CRP) in the observation group showed no significant difference ($t = 0.279$, $p = 0.781$; $t = 0.138$, $p = 0.891$); After 7 days of treatment, the levels of WBC and CRP in the observation group were lower than those in the control group ($t = 12.082$, $p < 0.001$; $t = 8.828$, $p < 0.001$), signifying a notable amelioration in inflammation in the observation group post-treatment (Table 3).

### 3.5 Adverse reactions

The incidence of adverse reactions (diarrhea, erythra, mild vomiting, exacerbation of asthma) in the observation group was lower than that in the control group ($\chi^2 = 4.000$, $p = 0.046 < 0.05$) (Table 4).

**TABLE 1. Comparison of patient efficacy (n (%)).**

| Group | n | Cured | Effective | Ineffective | Total effective rate |
|---|---|---|---|---|---|
| Observation group | 50 | 30 (60.00) | 15 (30.00) | 5 (10.00) | 45 (90.00) |
| Control group | 50 | 24 (48.00) | 12 (24.00) | 14 (28.00) | 36 (72.00) |
| $\chi^2$ | | | | | 5.263 |
| *p* | | | | | 0.022 |

**TABLE 2. Comparison of clinical indicators ($\bar{x} \pm s$, d).**

| Group | n | Cough disappearance time | Time of fever disappearance | Time of sputum disappearance | Time to lung rales disappearance |
|---|---|---|---|---|---|
| Observation group | 50 | 4.10 ± 0.52 | 1.60 ± 0.25 | 5.10 ± 0.28 | 4.45 ± 0.24 |
| Control group | 50 | 6.35 ± 0.83 | 3.20 ± 0.40 | 6.50 ± 0.50 | 6.50 ± 0.45 |
| *t* | - | 16.159 | 23.804 | 17.247 | 28.159 |
| *p* | - | <0.001 | <0.001 | <0.001 | <0.001 |

**TABLE 3. Comparison of inflammatory factors levels ($\bar{x} \pm s$).**

| Group | n | WBC ($\times 10^9$/L) | | CRP (mg/L) | |
|---|---|---|---|---|---|
| | | Before treatment | After 7 d of treatment | Before treatment | After 7 d of treatment |
| Observation group | 50 | 16.78 ± 3.50 | 6.58 ± 0.57 | 29.11 ± 4.54 | 5.27 ± 1.25 |
| Control group | 50 | 16.98 ± 3.37 | 8.35 ± 0.86 | 28.97 ± 5.02 | 8.70 ± 2.45 |
| *t* | - | 0.279 | 12.082 | 0.138 | 8.828 |
| *p* | - | 0.781 | <0.001 | 0.891 | <0.001 |

*WBC: white blood cells; CRP: C-reactive protein.*

**TABLE 4. Comparison of the complications (n (%)).**

| Group | n | Diarrhea | Erythra | Mild vomiting | Exacerbation of asthma | Total |
|---|---|---|---|---|---|---|
| Observation group | 50 | 1 (2.00) | 0 | 0 | 1 (2.00) | 2 (4.00) |
| Control group | 50 | 2 (4.00) | 1 (2.00) | 2 (4.00) | 3 (6.00) | 8 (16.00) |
| $\chi^2$ | - | | | | | 4.000 |
| *p* | - | | | | | 0.046 |

## 4. Discussion

In the early stages of adenovirus pneumonia in children, patients commonly present with fever [12]. As the disease progresses, the increase in body temperature can become significant. Respiratory symptoms, such as coughing are also prevalent. Research conducted in clinical settings has indicated that certain children may encounter symptoms such as nausea, vomiting, and diarrhea [13]. If not treated promptly, the condition can worsen, significantly increasing the risk of mortality [14]. In clinical practice, non-invasive treatment methods are often used, such as the administration of medications like ribavirin and recombinant human interferon $\alpha$2b. It is crucial to explore the mechanisms of action of these drugs and evaluate their clinical outcomes in order to improve treatment effectiveness and patient outcomes [15].

Currently, clinical treatment primarily focuses on conservative management, supplemented by antibacterial therapy, antispasmodics, bronchodilators, and antipyretics; however, the results are often unsatisfactory [16]. Interferon $\alpha$2b, a small protein that occurs naturally in the human body, is renowned for its ability to combat both DNA and RNA viruses due to its antiviral properties. It is extensively utilized in the treatment of viral infectious diseases [17]. The results of this study indicate that the total effective rate of the observation group was significantly higher than that of the control group, suggesting that the combination of interferon inhalation and immunoglobulin is more effective in treating pediatric adenovirus pneumonia than interferon nebulization alone. The reason for this improved efficacy may be due to the broad distribution of interferon $\alpha$2b in the human body, where rhIFN-$\alpha$2b plays a significant role in antiviral therapy by possessing broad-spectrum antimicrobial properties [18, 19]. The primary mechanism of interferon $\alpha$-2b's antiviral action involves blocking viral replication and proliferation. After entering the body, rhIFN-$\alpha$2b stimulates cells to generate antiviral proteins. This action results in the breakdown of viral mRNA and the blockage of its transcription, translation, and replication procedures. As a result, a wide-ranging antiviral impact is achieved and treatment effectiveness is improved [20, 21]. Moreover, interferon has the potential to boost the phagocytic capabilities of macrophages, thereby inhibiting the entry of

viruses into healthy cells. By utilizing nebulization, the medication can be swiftly administered to the patient's mucosal tissues, facilitating rapid absorption and efficiently managing the spread of the virus [22]. Clinically, immunoglobulin can be used to prevent infections from viral diseases like viral hepatitis and measles. When combined with antibiotics, it shows good efficacy in severe bacterial and viral infections [23]. Administering immunoglobulin to children as a form of passive immunotherapy for adenovirus pneumonia results in the rapid introduction of a high concentration of antibodies, effectively elevating the patient from a state of little to no immunity to a state of immune protection [24]. This interaction between antibodies and antigens neutralizes toxins within the body, kills viruses and bacteria, enhances immune function, and regulates immune cell levels, thus achieving therapeutic effects [25]. The synergistic effect of combining immunoglobulin and interferon leads to a decrease in lung parenchymal involvement, enhances the secretion of immune factors by the thymus, promptly alleviates clinical symptoms, and enhances the overall effectiveness of treatment [26, 27]. The clinical efficacy of using interferon $\alpha$2b alone has certain limitations, and most children do not achieve the desired therapeutic effect, leaving their immune system weak. Therefore, the combined use of both is more effective than using interferon aerosol alone. In the study by Liangkang Lin, a 10-month-old infant with severe adenovirus pneumonia complicated by plastic bronchitis (PB) was treated with intravenous ribavirin combined with aerosolized recombinant human interferon $\alpha$1b (IN$F\alpha$1b), which ultimately led to an improvement in his condition. No side effects were observed during the treatment, and the long-term prognosis was favorable. This report also demonstrated that the combination of IN$F\alpha$1b with other drugs appears to alleviate adenovirus pneumonia, consistent with the results of this study.

Following the treatment, it was observed that the duration of cough, fever, sputum production, and lung rales in the observation group was shorter in comparison to the control group. This indicates that the use of interferon and immunoglobulin in combination may lead to a swift alleviation of clinical symptoms in children. It is speculated that recombinant human interferon combined with immunoglobulin improves clinical symptoms by modulating immunity and reducing inflammation, thereby accelerating recovery, reducing hospitalization time, and enhancing clinical efficacy. Interferon $\alpha$2b occurs naturally in the human body. The recombination of interferon $\alpha$2b *in vitro* to produce recombinant human interferon $\alpha$2b is frequently utilized for antiviral therapy [28]. Upon entering the body, it induces cells to generate antiviral proteins continuously, inhibiting the gene expression process of viral mRNA [29]. Moreover, the use of recombinant human interferon $\alpha$2b is intended to modulate immune response, leading to improved macrophage and lymphocyte activities in children, consequently contributing to better disease prognosis [30]. Immunoglobulin inhibits the formation of antigen-antibody complexes to some extent, reducing inflammatory responses. Inhibiting alveolar exudation can enhance clinical symptoms in children [31, 32]. The combination of the two may improve clinical symptoms of adenoviral pneumonia through synergistic inhibition of inflammation and enhancement of immunity, thereby exerting therapeutic effects. Consequently, the combined use shortens the time required to improve clinical symptoms in children. In the research conducted by Cai Sha, a total of 75 children who were 14 years old or younger and diagnosed with severe adenovirus pneumonia (AVP) were enrolled. They were categorized into three groups (A, B and C) according to the sequence of their visits, with 25 children in each group. Group A received only symptomatic supportive treatment. In addition to symptomatic supportive treatment, Group B received intravenous immunoglobulin (IVIG) treatment at a dose of 1 g/(kg·d) for 2 consecutive days before progressing to severe AVP. Group C received the same IVIG treatment after progressing to severe AVP. The efficacy and related laboratory indicators were compared among the three groups after treatment. The results showed that Group B had the shortest fever duration and hospital stay after treatment. The findings indicate that IVIG treatment before progression to severe AVP is more effective in treating children with severe adenovirus pneumonia, directly demonstrating the efficacy of IVIG treatment for severe adenovirus pneumonia in children.

After 7 days of treatment, the levels of WBC and CRP in the observation group were significantly lower than those in the control group. This suggests that interferon aerosol combined with immunoglobulin can markedly reduce inflammation in children. This effect may be due to the enhanced antiviral activity from the combination therapy, which improves clinical symptoms and boosting immune function in children. Immunoglobulin, a key immune component produced by lymphocytes, can block cell Fc receptors and inhibit cytokine production to some extent, thereby reducing the release of pro-inflammatory factors in the bronchi and preventing the formation of antigen-antibody complexes [33]. It works to counteract inflammatory agents within the body, thereby boosting the immune system of the child. Immunoglobulin serves as a shield not only against bacterial infections (such as Staphylococcus aureus, Corynebacterium diphtheriae, Streptococcus) but also demonstrates effectiveness in combating viral infections like adenovirus, echovirus, and respiratory syncytial virus [34]. The product consists of a variety of antibodies targeting human tumor necrosis factor, interleukin-1, and interleukin-6. These antibodies work by directly inhibiting the activity of these cytokines, leading to anti-inflammatory outcomes [35]. Additionally, immunoglobulin reduces alveolar exudates, prevents mucus obstruction in the respiratory tract, thereby decreasing severe complications and alleviating symptoms in children [36, 37]. Recombinant human interferon functions by attaching to interferon receptors located on the surface of target cells. This action triggers the generation of various antiviral proteins that hinder viral replication, synthesis, and transcription. Consequently, this process helps to dampen the inflammatory response [38]. Therefore, the combined use of interferon and immunoglobulin can effectively improve microcirculation, decrease inflammation, and regulate immune function. The observation group experienced fewer complications than the control group, indicating that recombinant human interferon $\alpha$2b aerosol inhalation combined with immunoglobulin is safe, with a low incidence of adverse reactions and high tolerability.

This study is constrained by a limited sample size and a lack

of thorough investigation into patient baseline characteristics, such as pre-existing medical conditions. The single-center design and younger age of the study population may also limit the generalizability of the findings. Additionally, there is a lack of research on factors influencing the recurrence rate. Supplementing this data will enhance understanding of the impact of these therapies on disease recurrence. Moreover, there is still a need for more in-depth investigation into the risk factors associated with complications. It is essential to conduct additional analysis in order to enhance the effectiveness of treatment and overall clinical care. Future studies should involve larger, more diverse samples, multi-center designs, and detailed analysis of complication risk factors and recurrence rates to improve the accuracy and comprehensiveness of the findings.

## 5. Conclusions

In summary, the combination of immunoglobulin and interferon aerosol therapy demonstrates significant clinical efficacy in treating children with adenoviral pneumonia. It quickly relieves clinical symptoms (shortening the disappearance time of cough, fever, sputum, and lung rales), decreases levels of inflammatory response (reducing WBC count and CRP levels), enhances immune function, and helps them recover quickly. The treatment demonstrates a favorable safety profile, rendering it appropriate for clinical application.

### AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

### AUTHOR CONTRIBUTIONS

QZ—designed the study and carried them out; prepared the manuscript for publication and reviewed the draft of the manuscript. QZ, FQX and FZC—supervised the data collection, analyzed the data, interpreted the data. All authors have read and approved the manuscript.

### ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of Anhui Provincial Children's Hospital Approval no. 2023029). Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article.

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### CONFLICT OF INTEREST

The authors declare no conflict of interest.

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