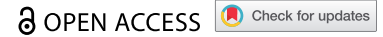


SHORT REPORT



# Hospitalization costs for children with pneumonia in Shanghai, China from 2019 to 2020

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## ABSTRACT

Pneumonia is the leading cause of death in children under 5 years of age worldwide. In this study, we primarily analyzed the hospitalization costs for children diagnosed with pneumonia in one of the leading public hospitals in Shanghai, China. Furthermore, factors affecting the hospitalization costs for children with pneumonia were evaluated. Data on case diagnosis, hospitalization time, age and various hospitalization expenses were collected. Total hospitalization expense for the 149 cases was \$177,750, with an average total cost of \$1,193 per person and an average out-of-pocket cost of \$642. The highest per capita expenses included fees for laboratory diagnosis (\$418), general medical service (\$235), western medicine (\$253), and antibacterial drugs (\$158). The leading diagnosis was bronchopneumonia, with 68 (46%) cases, an average hospital stays of 7.4 days, and average hospitalization expenses of \$1,068. Considering the high burden of pneumonia in children, hospitals and governments must make more reasonable use of limited resources of the medical system. At the same time, various types of medical insurance should be added into the children's medical security system, encourage vaccination with pneumonia vaccines (13-valent pneumococcal conjugate vaccine and 23-valent pneumococcal polysaccharide vaccine), and ensure that more children benefit from the vaccine by including it in the national immunization program.

## ARTICLE HISTORY

Received 22 December 2021  
Revised 11 May 2022  
Accepted 20 May 2022

## KEYWORDS

Pneumonia; children; hospitalization expenses; out-of-pocket cost

## Introduction

Pneumonia is the leading cause of death in children under 5 years of age worldwide.<sup>1,2</sup> Globally, pneumonia accounted for 14% of all deaths of children under 5 years old, killing 740 180 children in 2019.<sup>3</sup> The absolute number of pneumonia deaths in China has declined. However, pneumonia remains a major cause of morbidity in children in the country.<sup>4</sup> An estimated 156 million annual pneumonia cases - of which 7% to 13% require hospitalization - occur globally. The World Health Organization (WHO) estimates that pneumonia accounted for greater than 900,000 deaths in children of all ages worldwide, with 16% of these deaths in children under 5 years of age.<sup>5</sup> In the Western Pacific region, the incidence of pneumonia in children under 5 years was 0.11 in 2011, with 61,900 children dying of pneumonia.<sup>6</sup> The disease has become an important public health problem affecting healthy growth in children, and its economic burden to patients, families, and society is considerably higher than that of other common pediatric diseases. In this study, we primarily analyzed the hospitalization costs for children diagnosed with pneumonia in one of the leading public hospitals in Shanghai, the most developed city in China. The study provides a reference for comparison with other countries and other regions in China. Furthermore, factors affecting the hospitalization costs for children with pneumonia were evaluated to identify effective ways to reduce hospitalization costs, improve hospital efficiency, and reduce social burden.

## Methods

### Data collection

Data were collected from a leading public general hospital in Shanghai. For the study, we were authorized access exclusively to data on case diagnosis, hospitalization time, age, and various hospitalization expenses. Because of the hospital's confidentiality and personal privacy concerns, we were not authorized access to patient medical history data. Data for this study therefore included the various types of expenses, hospitalization time, and diagnostic information of cases, but did not include personal information and case medical histories. All cost data were from the hospital's financial system. Data for children under 5 years of age diagnosed with pneumonia were from 1 January 2019 to 31 December 2021. All data were anonymized before access.

### Cost classification

In China, medical treatment and hospitalization expenses are divided according to payment source into two categories: out-of-pocket and medical insurance. The ratio of out-of-pocket cost to insurance payment is calculated by dividing the total out-of-pocket cost by the total insurance payment.

Hospital drug fees in China are categorized as traditional Chinese medicine fees and western medicine fees—which refer to all drug costs excluding those for traditional Chinese medicine. Only the cost of antibiotics is listed separately and serves

as a control indicator of antibiotic overuse in Chinese hospitals. The classification of drug costs in this study is therefore based entirely on data provided by the hospital and includes the costs of Western drugs, antibiotics, and traditional Chinese medicine—which refers to traditional Chinese herbs and proprietary Chinese medicines. The cost of cytokines is listed separately in a special category; however, the circumstances under which cytokines were used were unknown because of the absence of case histories.

Other cost categories include diagnostic costs, which refer to laboratory and imaging expenses associated with diagnosis. The service fee covers the cost of medical personnel for treatment and services. Material cost refers to the expense for materials used in medical checkups and for treatment while patients wait for hospital admission. Some cases further underwent surgical treatment, the cost of which was not included in the treatment cost.

### Diagnostic classification

Case diagnoses were classified according to the ICD code provided by the hospital. Given medical records, examination data, and case histories were not available, evaluating and further categorizing diagnoses was not possible. As such, the diagnoses presented in the study were entirely classified and compared in accordance with the diagnoses provided by the hospital.

### Exchange rate

All expenses were converted to US dollars at the Renminbi–US dollar (RMB/USD) exchange rate of 6.3896, which was based on the central parity of the RMB exchange rate published by the China Foreign Exchange Trade Center in the inter-bank foreign exchange market on 15 April 2022.

### Statistical methods

The study primarily analyzed the composition of hospitalization expenses using descriptive analysis. Total costs included all expenses incurred during the patient's hospitalization and were derived from the hospital's financial system. Average hospitalization costs were defined as costs incurred for all cases divided by the number of cases. Average length of stay was calculated as the total length of stay divided by the number of cases, while the average daily hospitalization cost was the average hospitalization cost divided by the average length of stay in days. Descriptive statistics included mean and 95% confidence interval. Factors influencing hospitalization expenses were analyzed by analysis of variance. Statistical analysis was performed using STATA 16.0 software (StataCorp, College Station, TX, USA) and  $P < 0.05$  was defined as a statistically significant difference.

## Results

### Basic information

A total of 149 cases were diagnosed with pneumonia-related disease in one of the leading public hospitals in Shanghai from 1 January 2019 to 31 December 2020. The cases included 83 males and 66 females, translating to a male: female ratio of 1.3:1. Mean age was 2.9 years and mean hospitalization stay was 7.9

days. The seasonal distribution was as follows: 28 cases (18.8%) in spring, 20 cases (13%) in summer, 34 cases (23%) in autumn, and 67 cases (45%) in winter.

### Hospitalization cost

Total hospitalization expense for the 149 cases was \$177,750, with an average total cost of \$1,193 per person and an average out-of-pocket cost of \$642. The highest per capita expenses included fees for laboratory diagnosis (\$418), general medical service (\$235), western medicine (\$253), and antibacterial drugs (\$158; Table 1). No significant differences in hospitalization cost were observed when age, gender, and main diagnosis were compared between the groups. The length of hospitalization was significantly related to total cost ( $F = 46.56$ ,  $P < 0.05$ ); hence, the longer the hospital stay, the higher the cost. The lowest and highest out-of-pocket costs were \$0 and \$642, respectively, while the highest and average out-of-pocket costs were \$1,013 and \$642, respectively. The total out-of-pocket cost was \$95,657 while total medical insurance payment was \$82,094, representing an out-of-pocket cost to insurance payment ratio of 1.16:1.

### Diagnosis classification

The leading diagnosis was bronchopneumonia, with 68 (46%) cases, an average hospital stays of 7.4 days, and average hospitalization expenses of \$1,068 (Table 2). *Mycoplasma pneumoniae* was diagnosed in 28 (19%) cases, with an average hospital stay of 8.6 days and average hospitalization expenses of \$1,250. Seventeen (11%) cases of community-acquired pneumonia and 15 (10%) cases of asthmatic bronchopneumonia were observed. One case of lung abscess accompanied by pneumonia had the highest hospitalization expense of \$3,151 for 14 days of hospital stay, while one case of non-severe bronchopneumonia was associated with an average hospitalization cost of \$683 and a 7-day hospital stay.

## Discussion

China has one of the highest incidences of pneumonia in children. The incidence of pneumonia in children under 5 years of age in China was 0.22 person-years, the incidence of hospitalization was 0.78%–1.40%, and the per capita hospitalization cost was \$829.6.<sup>7</sup> The average hospitalization cost for pneumonia in children in our study was \$1,193, higher than the Chinese average. The average medical expenditure was \$3,376 in the United States<sup>8</sup> for children with pneumonia under 5 years of age and €1,508 (approximately \$1,625) in the Netherlands for children with pneumonia under 9 years of age.<sup>9</sup> The burden of hospitalized community-acquired childhood pneumonia was \$145 in Vietnam and \$1,013.3 in the Republic of Korea.<sup>10</sup> In summary, our study indicated that the average hospitalization cost for pneumonia in children under 5 years of age was higher than average costs in China and Asia countries, but lower than those in European countries and the United States.

**Table 1.** Composition of hospitalization expenses of children with pneumonia in Shanghai, China from 2019 to 2020.

Cost classification	Total cost		Mean cost		
	Cost (\$)	Percentage (%)	Cost (\$)	Standard error	95%CI
Total hospitalization cost	177750		1193	72	1050~1335
Out-of-pocket cost	95657	54	642	83	479~805
Diagnostic cost	65835	37	442	12	418~466
Laboratory fees	62255	35	418	11	397~439
Imaging fees	2187	1	15	2	11~19
Fees for clinical diagnosis	1393	1	9	1	7~12
Expenses for medicine	38116	21	256	49	159~353
Cost of western medicine	37736	21	253	49	157~349
Cost of antibiotics*	23527	13	158	41	77~239
Cost of Chinese traditional medicine	224	0	2	0	1~2
Cytokine fee	156	0	1	1	-0.3~2
The service fee	62060	35	417	27	363~470
General medical services fee	42268	24	235	332	235~332
General treatment fee	8024	5	48	59	48~59
Nursing fee	9770	6	61	70	61~70
Other service fee	1998	1	11	16	11~16
Materials expenses	11727	7	79	4	71~87
One-time medical materials used for examinations	6	0	0	0	0~0.1
Disposable medical materials for treatment	11049	6	74	3	68~81
One-time medical materials used for surgery	30	0	0	0	-0.2~0.6
Other material expenses	642	0	4	1	2~6
Surgical treatment expense	23	0	0	0	-0.1~0.4
Surgical treatment fee	12	0	0	0	0~0.2
Anesthesia fee	2	0	0	0	0~0
Operation fee	9	0	0	0	-0.1~0.2

\*The cost of antibiotics is included in the cost of western medicine, and 13.24% is the proportion of antibiotics in the total hospitalization cost.

**Table 2.** Pneumonia types and hospitalization expenses in Shanghai from 2019 to 2020.

Diagnostic classification	No. of cases	Proportion (%)	Total cost (\$)	Mean cost (\$)	Average length of hospitalization (days)	Average daily hospitalization cost (\$)
Bronchopneumonia	68	46	72638	1068	7.4	145
Mycoplasma pneumonia	28	19	34994	1250	8.6	146
Community acquired pneumonia, non-severe	17	11	17825	1049	7.4	143
Asthmatic bronchopneumonia	15	10	18661	1244	8.6	145
Pneumonia	7	5	16394	2342	11.4	205
Lobar pneumonia	6	4	8119	1353	8.7	156
Severe pneumonia	3	2	2654	885	3.7	241
Mycoplasma pneumoniae acute bronchitis	2	1	1257	629	4.0	157
Viral pneumonia	1	1	1375	1375	14.0	98
Lung abscess with pneumonia	1	1	3151	3151	14.0	225
Bronchopneumonia, non-severe	1	1	683	683	7.0	98
Total	149	100	177750	1193	7.9	150

In view of the high proportion of expenditures going to drugs and examinations in Chinese hospitals, the Chinese government in recent years has launched a series of measures—such as separating medical treatment and pharmaceutical services—to reduce these costs. However, the proportions of examination and drug costs remain high at 37% and 21%, respectively. Testing and drug costs normally account for a higher proportion of medical expenditures in China. However, in this study, the proportion representing the medical service fee (35%) was significantly higher than that in Hu's study in Beijing (13. % from 2015 to 2017)<sup>11</sup> and Zhang's study in Guangdong Province (13% in 2017).<sup>12</sup> The high proportion of medical service expenses indicates the increase in the medical staff's remuneration, which to some degree reflects the value of medical service.

The average length of hospitalization was 7.9 days, which was similar to that of the Beijing study (7 days),<sup>13</sup> but higher than the 5 days recommended by the WHO and the average 5.8 days in the latest global systematic review of pediatric pneumonia treatment.<sup>14</sup> The use of a severity score has been proposed to rate the severity of pneumonia as a way to assess the need for hospitalization.<sup>15</sup> Accordingly, outpatient treatment or a shorter length of hospital stay for less severe patients can substantially reduce the cost of hospitalization and the burden on hospitals. This is especially useful given the additional strain on pediatric resources following the Chinese government's cancellation of its family planning policy and its recent encouragement of childbirth. Hospitals and governments must make more reasonable use of limited resources to avoid the bankruptcy of the medical system.

While hospitalization expenses are paid by medical insurance and by individuals, the proportion of individual payment is higher than that of medical insurance. The coverage level and amount of social medical insurance for children are limited, and some families in China do not purchase medical insurance for children. In addition, basic medical insurance systems are largely constrained by the level of local economic development, with a considerable gap observed between eastern China and the more underdeveloped regions of China.<sup>16</sup> Shanghai's per capita gross domestic product is already at the upper-middle level in the world, and its level of medical insurance coverage is better than that of other regions in China.<sup>5</sup> In Shanghai, medical insurance for children generally consists of residents' basic medical insurance and financing from the children's hospitalization mutual aid fund managed by the Shanghai branch of the Red Cross Society. This fund is self-raised and provides an important supplement to the medical insurance system in cases in which the government does not provide children's medical insurance.<sup>17,18</sup> Commercial medical insurance should be added as a supplement to the children's medical security system to increase children's welfare and to prevent high childhood medical costs from becoming a heavy burden on families.

Many pathogenic microorganisms cause pneumonia. *Streptococcus pneumoniae* and *Haemophilus influenzae* type b are the main pathogens.<sup>19,20</sup> Influenza, pneumococcal, and *Haemophilus influenzae* type b conjugate (Hib) vaccines are recommended in children;<sup>19</sup> some countries have included these vaccines in their national immunization programs (NIPs).<sup>21</sup> Meanwhile, all these vaccines are not included in Chinese NIPs which are vaccinated at their own expenses. Vaccination is an effective specific preventive measure and can reduce medical and family economic burdens.

In China, the 13-valent pneumococcal conjugate vaccine is currently available for children aged 6 weeks to 5 years, while the 23-valent pneumococcal polysaccharide vaccine is available for adults and children aged 2 years and older. However, studies show that only 26.74% of urban children are vaccinated. A lower hospitalization rate and lower costs were observed for individuals vaccinated with pneumonia vaccines compared with their unvaccinated counterparts.<sup>22</sup> Furthermore, children vaccinated with at least one dose of pneumonia vaccine had lower hospitalization costs than unvaccinated children.<sup>23</sup> Meanwhile the vaccination coverage of Hib vaccines and influenza vaccines for children are 55.9%<sup>24</sup> and 26.84%.<sup>25</sup> In the future, the government should increase its investment in preventive health, encourage vaccination with pneumonia vaccines, and ensure that more children benefit from the vaccines by including it in the NIPs.

## Limitations

Because the hospital did not authorize access to case medical histories for this study, we could not obtain more information about the diagnosis, treatment, and outcome of cases. We are continuing efforts to obtain case history information for future research. Second, the study was based on data from one public hospital in Shanghai, and therefore lacked data from private

hospitals and hospitals in other regions. Further research is needed to compare the differences in hospitalization costs between types of hospital and regions.

## Data availability statement

The datasets analyzed during the current study are not publicly available due to the provision on confidentiality of information of Huangpu CDC but are available from the corresponding author on reasonable request.

## Ethical approval and consent to participate

All data were anonymous before access. All methods were performed in accordance with the relevant guidelines and regulations. Consent to participate is not applicable.

## Funding

This work was supported by Yangtze River Delta Regional Leading Talents Research Project on Immunization [CS]P032].

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