

Does Pneumococcal Vaccination Have an Effect on Hospital Costs?

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Abstract

OBJECTIVE: It is known that inpatient hospital costs are much higher than outpatient services. It was aimed to investigate the effect of pneumococcal vaccination on hospitalizations.

MATERIAL AND METHODS: The direct hospitalization costs, length of stay, and factors of the vaccinated and unvaccinated patients in the same hospital during the 12-month follow-up of the patients who received pneumococcal vaccine between November 15, 2018, and November 15, 2020, in 3 chest diseases and thoracic surgery training and research hospitals were analyzed by obtaining Hospital Information Management System records. Data were collected with Statistical Package for the Social Sciences version 23 program (IBM Corp.; Armonk, NY, USA), and statistical evaluation was made.

RESULTS: The mean age of 800 hospitalized patients, of whom 400 were unvaccinated and 400 were vaccinated, was 68.48 ± 11.97 . There was no significant difference in the mean age of vaccinated and unvaccinated patients ($P > .05$). Five hundred sixty-six patients (70.8%) were aged 65 and over. Two hundred eighty (51.2%) of men were vaccinated and 120 (47.2%) of women were vaccinated, and there was no significant difference ($P > .05$). The mean hospital stay of these patients was 11.01 days, and those in the vaccinated group had an average mean hospital stay of 9.11 days and those in the unvaccinated group had a mean hospital stay less than 12.91 days ($P < .001$). Total 1-year hospitalization costs were \$501.653.53 and the cost per person was calculated as \$627.07. The cost per capita for the vaccinated group was \$550.52, which was lower than the average cost of the unvaccinated group (\$703.62) ($P < .05$). When comparing the status of being vaccinated, comorbidity, mortality, mean length of stay, chronic obstructive pulmonary disease, and heart disease were found to be statistically significant ($P < .05$).

CONCLUSION: In our study, it was revealed that vaccination of patients hospitalized in chest disease hospitals with the pneumococcal vaccine reduced the average length of hospital stay by 41.7% and the cost of hospitalization by 27.8%.

KEYWORDS: Pneumococcal vaccination, hospital costs, vaccination and hospitalization

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INTRODUCTION

Respiratory diseases are among the leading causes of death worldwide. World Health Organization estimates that by 2030, 4 potentially fatal respiratory diseases [pneumonia, tuberculosis, lung cancer, and chronic obstructive pulmonary disease (COPD)] will be responsible for approximately 1 in 5 deaths worldwide. Asthma causes a small number of deaths but is an important cause of disability. Therefore, respiratory diseases will likely continue to be a major burden on European societies and the world for the following decades. Both the prevention and treatment of lung diseases must be improved if their impact on the longevity and quality of life of individuals worldwide and the economic burden on society is to be reduced.¹

Pneumococcal pneumonia constitutes a significant portion (20%-50%) of community-acquired pneumonia (CAP). About 10%-30% of these are accompanied by bacteremia.²

Non-bacteremic pneumococcal pneumonia is responsible for approximately 30% of hospitalizations due to CAP.³ According to the culture results obtained from studies conducted in different centers in our country, *Streptococcus pneumoniae* was the most common cause of CAP (20.9% across the country).⁴

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Morbidity and mortality due to CAP are higher in advanced age (65 years and over) compared to the young population, and it causes hospitalization more frequently (22%-42%).⁵ In the elderly, the risk of pneumococcal pneumonia is high, hospitalization is higher, and the recovery period for CAP is longer.⁶ Given the course and associated morbidity and mortality of pneumococcal disease in older adults and those with specific comorbidities, prevention of the disease in these individuals is important.

Chronic obstructive pulmonary disease is a severe chronic lung disease characterized by progressive airway limitation, whose importance and frequency are increasing worldwide. Chronic obstructive pulmonary disease progresses with exacerbation episodes, and it has been reported that approximately 50% of exacerbations are of bacterial origin, and the most common cause is *S. pneumoniae*.⁷

It has been reported that 6% of the general health care budget in European Union countries is related to respiratory diseases, and 56% (€38.6 billion) of this cost is secondary to COPD.⁸

The total annual direct and indirect cost of CAP in an adult with a risk factor in the USA is 2.7 times higher than that of a patient without a risk factor.⁹ In a study conducted in our country in 2017, it was shown that the total mean cost in adults with a diagnosis of CAP over the age of 18 was 10.9 times higher in hospitalized patients (€556.09 ± 1004.77 vs. €51.16 ± 40.92).¹⁰ The cost of those treated at the hospital was higher regarding laboratory, medication, and hospital fees.¹¹

In addition to the burden that COPD, asthma, and elderly patients with these diseases bring to the health system, CAPs that may occur in these patients and therefore hospitalizations will also cause an additional cost. If the annual losses of chronic respiratory diseases due to disability are added, it is evident that there will be a significant increase in the annual costs of COPD and asthma.

Especially in risk groups, in addition to reducing the medical burden, pneumococcal vaccination may also provide economic benefits by reducing hospitalization due to its contribution to the prevention of disease and attacks. Based on this, we aimed to investigate the effect of pneumococcal vaccination on hospitalization costs in this study, which we carried out in 3 chest diseases training and research hospitals.

MATERIAL AND METHODS

This multicenter cohort study was performed after obtaining approval from the University of Health Sciences Süreyyapaşa Chest Diseases and Thoracic Surgery Training and Research

Hospital scientific board and hospital ethical committee (01.11.2018/2018-32).

In a 12-month follow-up of patients who received 13-valent pneumococcal conjugate vaccine (PCV13) between November 15, 2018, and November 15, 2020, in 3 chest diseases and thoracic surgery training and research branch hospitals (İstanbul Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, İzmir Dr. Suat Seren Chest Diseases and Thoracic Surgery Training and Research Hospital, and İstanbul Süreyyapaşa Chest Diseases and Thoracic Surgery Training and Research Hospital), those who were hospitalized and those who were not vaccinated in the same period and were hospitalized, were analyzed in terms of direct hospitalization costs, length of stay, and factors affecting them by obtaining Hospital Information Management System records. Intensive care hospitalizations were excluded from our study.

Hospitalizations due to pneumonia, COPD and Asthma attack, and malignancy and patients over the age of 18 who completed the follow-up period or died during this period were included in the study. Intensive care hospitalizations and HIMS record could not be reached, patients under the age of 18 and those with contraindications for vaccination were excluded from our study.

The total cost of hospitalization and intervention, medication, examination, and additional services were recorded by reviewing the hospital automation system, and hospitalization costs were compared according to the recorded data.

Statistical Analysis

Data were recorded and statistically evaluated with the Statistical Package for the Social Sciences version 23 program (IBM Corp.; Armonk, NY, USA). Descriptive statistics were given as numbers and percentages for categorical variables and mean and SD for numerical variables. A chi-square test was used to determine whether if there was a significant difference between vaccination status and categorical variables, and the Student's *t*-test was used for comparisons between vaccination status, cost, and length of stay. Multiple linear regression analysis was performed to determine the functional relationship between the factors affecting the cost. *P* < .05 was considered significant.

RESULTS

The mean age of 800 patients included in our study, 400 unvaccinated, 400 vaccinated, and hospitalized in 3 hospitals for 2 years, was 68.48 ± 11.97 (68.61 ± 12.95 in vaccinated and 68.34 ± 10.92 in unvaccinated patients). There was no significant difference between the mean age of the vaccinated and unvaccinated patients (*P* > .05). Five hundred sixty-six patients (70.8 %) were aged 65 and over, and there was no significant difference between the rates of vaccinated and unvaccinated patients (*P* > .05, 69.5%, 72.0%).

There were 546 (68.2%) men and 254 (31.8%) women, of which 280 (51.0%) of the men were vaccinated and 120 (47.2%) of the women were vaccinated, and there was no statistically significant difference in gender comparison (*P*

MAIN POINTS

- Patients with pneumococcal vaccine have shorter hospital stays.
- Patients with pneumococcal vaccine have lower mortality rates.
- For these reasons, hospital costs were found to be significantly less.

Table 1. Comparison of Vaccination Status and Demographic Variables

Variables		Total (n = 800)		Unvaccinated (n = 400)		Vaccinated (n = 400)		P
		n	%	n	%	n	%	
Gender	Male	549	68.6	269	67.3	280	70.0	.402
	Female	251	31.4	131	32.8	120	30.0	
Age group	<65	237	29.6	125	31.3	112	28.0	.314
	≥65	563	70.4	275	68.8	288	72.0	
Mortality	Live	728	91.0	341	85.3	387	96.8	<.001
	Dead	72	9.0	59	14.8	13	3.3	
Comorbidity	No	250	31.25	149	37.25	101	25.25	<.001
	Yes	550	68.75	251	62.75	299	74.75	
Asthma	No	759	94.87	382	95.5	377	94.25	.423
	Yes	41	5.125	18	4.5	23	5.75	
COPD	No	446	55.75	242	60.5	204	51.0	.007
	Yes	354	44.25	158	39.5	196	49.0	
Pneumonia	No	500	62.5	260	65.0	240	60.0	.144
	Yes	300	37.5	140	35.0	160	40.0	
Diabetes	No	788	98.5	397	99.25	391	97.75	.141
	Yes	12	1.5	3	0.75	9	2.25	
Hypertension	No	783	97.87	384	96.0	399	99.75	<.001
	Yes	17	2.125	16	4.0	1	0.25	
Heart diseases	No	738	92.25	392	98.0	346	86.5	<.001
	Yes	62	7.75	8	2.0	54	13.5	

COPD, chronic obstructive pulmonary disease.

> .05). The mortality rate of our patients was 3.3% in the vaccinated group and much less than 15.2% in the unvaccinated group, and statistical significance was found ($P < .001$). When comparing vaccination status with additional diseases, there is a statistically significant difference between the presence and absence of additional disease, COPD, and heart disease ($P < .05$). The presence of additional disease, COPD, and heart disease rates is higher in vaccinated people (Table 1), because patients in this group are vaccinated at a higher rate.

The mean hospital stay of these patients was 11.01 days and those in the vaccinated group had an average mean hospital stay of 9.11 days and those in the unvaccinated group had a mean hospital stay less than 12.91 days ($P < .001$) (Table 2).

Total 1-year hospitalization costs were \$501.653.53 and the cost per person was calculated as \$627.07. The cost per capita of the vaccinated group was calculated as \$550.57, which

was less than the average cost of the unvaccinated group, which was \$703.62 ($P < .05$).

When the factors affecting the invoice amount were examined by multiple linear regression analysis, the status of being vaccinated, length of stay, mortality, and heart disease were statistically significant ($P < .05$). It was observed that the status of being vaccinated, having less length of stay, having low mortality, and not having heart disease significantly reduced the cost of hospitalization (Table 3).

DISCUSSION

The costs of diseases are evaluated in 2 groups, direct and indirect costs. Indirect costs include costs resulting from loss of workforce and productivity due to disease-related restrictions, disability, and premature death, while direct costs include medication, diagnostic methods, follow-up, outpatient, emergency room, and hospitalization. Hospitalization

Table 2. Vaccination Status vs. Length of Stay and Cost

Variables	Total (n = 800)		Unvaccinated (n = 400)		Vaccinated (n = 400)		P
	Mean	SD	Mean	SD	Mean	SD	
Cost	3781.8454	5673.1697	4231.6153	6805.4092	3332.0756	4210.8405	0.025
Length of stay	10.76	12.67	12.41	15.71	9.11	8.34	<0.001

Table 3. Multiple Linear Regression Analysis of Factors Affecting the Cost

Independent variables	B	SE	Beta	t-Test Value	P
Vaccination	-899.540	400.140	-0.079	-2.248	.025
Gender	546.723	432.100	0.045	1.265	.206
Age	-6.582	17.212	-0.014	-0.382	.702
Length of stay	354.963	9.653	0.793	36.773	.000
Mortality	1437.879	699.462	0.073	2.056	.040
Comorbidity	-347.824	432.828	-0.028	-0.804	.422
Asthma	61.154	910.183	0.002	0.067	.946
COPD	-813.639	403.058	-0.071	-2.019	.044
Pneumonia	455.457	414.256	0.039	1.099	.272
Diabetes	876.040	1650.868	0.019	0.531	.596
Hypertension	-1980.663	1389.906	-0.050	-1.425	.155
Heart	1616.880	748.432	0.076	2.160	.031

COPD, chronic obstructive pulmonary disease.

costs constitute the most important part of the direct health costs.¹² Pneumococcal infections are a very important cause of mortality and morbidity in chronic lung diseases. The hospitalization rate in patients with CAP varies between 30% and 60%.^{13,14} It has also been reported that more than 95% of the treatment costs of CAP are due to hospitalized patients.¹³

The most important factor for cost is the length of stay in the hospital. Other factors include the treatment applied and the patient's compliance with the treatment.^{15,16} International studies have reported that the length of stay varies between 5 and 11 days.¹⁷⁻²⁰

Our study found high hospitalization times of 10.76 days on average: 9.11 and 12.41 days in vaccinated and unvaccinated patients, respectively. We can attribute this situation to the fact that the centers where the study took place were branch hospitals, and most patients were patients with respiratory failure who may require oxygen or non-invasive mechanical ventilation support.

In the study of Ortaköylü et al.²¹ 1-year activity-based costs related to COPD were calculated and found to be US\$3 839 788.32. Annual expenditure for inpatients has been reported to be US\$2 531 290.91 (630.14 USD per person = 959.70 TRY) for 4017 COPD patients with social security institute (SSI) prices.

Different studies have shown that patients with COPD and pneumonia have increased rates of intensive care unit (ICU) hospitalization, ICU length of stay, and 30- and 90-day mortality compared with those without pneumonia.^{22,23} These studies reveal the significant disease burden caused by pneumonia in COPD patients.²⁴

The pneumococcal vaccine is indicated for adults who are at risk for pneumonia or who may have serious adverse consequences if they contract pneumococcal pneumonia. In order to prevent pneumococcal diseases, although the recommended groups for vaccination are determined by the

guidelines and the vaccines are paid for by the health authorities, the vaccination rates in chronic lung diseases in Turkey are at very low levels as in the rest of the world. At the same time, it was stated that vaccination awareness was low, and the factor most cited as the cause of not being vaccinated was not being recommended by doctors.²⁵

Vaccination has significantly reduced the burden of infectious diseases worldwide. Considering that there are limited resources for health services, determining the necessary strategies and taking steps in this direction are important in terms of using health resources efficiently.²⁶

Every extra day spent in the hospital will increase the total cost. Our study revealed that vaccinating patients hospitalized in chest disease hospitals with the pneumococcal vaccine reduced the average hospital stay by 41.7% and the cost of hospitalization by 27.8%. If all hospitalized patients had pneumococcal vaccination, 1518 hospitalization days would have been gained annually. Moreover, SSI would have paid less for these patients, totaling 8958.02\$ per year. In order to reduce the burden on the health system, preventive medicine practices and public health planning should be done correctly and put into action. Treatment of respiratory diseases such as COPD and asthma, taking necessary measures to reduce attacks, and raising awareness of patients on this subject will reduce direct and indirect costs by preventing the progression of the disease and the loss of workforce, as well as reducing hospitalizations. Here, vaccination prevents both the exacerbation of the disease and the more severe course of the disease in patients who need hospitalization, helping them to be discharged as soon as possible. Improving home care facilities will reduce the number of emergency services applications and the total cost.

In terms of factors affecting the cost of our study, intensive care admissions were not taken into account since the results of comorbidity and bacteriological analysis were missing. The effect on mortality rates in hospitalized patients could not be found. The effect of pneumococcal vaccination on hospitalization rates could not be investigated.

Ethics Committee Approval: This study was approved by the University of Health Sciences Süreyyapaşa Chest Diseases and Thoracic Surgery Training and Research Hospital Scientific Board and Hospital Ethical Committee (01.11.2018/2018-32).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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