RESEARCH ARTICLE

Socioeconomic Burden of Community-acquired Pneumonia Associated Hospitalizations among Vietnamese Patients: A Prospective, Incidence-based Study

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Abstract

Context: Community-acquired pneumonia (CAP) is a leading cause of morbidity and mortality. **Aims:** This paper presents a study that was conducted to assess the socioeconomic effects of a CAP episode to help policymakers to create effective prevention and control measures. **Settings and Design:** This study used an incidence-based approach from a societal perspective. **Materials and Methods:** The sample comprised 255 hospitalized patients at the Respiratory Department at Trung Vuong General Hospital during a 12-week period in 2017. Payment data were also collected. **Results:** Overall, there were 148 (58.0%) men and 107 (42.0%) female with a mean age of 66 ± 16 years. More than half 158 (62.0%) were older than 65. The current study showed the mean treatment cost to be approximately $629 for CAP inpatients; this included direct and indirect costs. The average informal cost of treating one CAP patient was estimated at $297. On average, the biggest expenses were those related to direct medical costs - 76.6% ($481). The mean CAP-related direct non-medical and indirect costs accounted for 19.3% and 4.1%, valued at $121 and $26, respectively. The results of the study also showed a significant relationship between length of stay and average cost of treatment per CAP episode. **Conclusions:** The results of this study can be used to improve the allocation of resources for CAP control in Vietnam and to provide a foundation for future analyses of the cost-effectiveness of pneumococcal vaccines or other methods for controlling CAP.

Key words: Community-acquired pneumonia, direct cost, indirect cost, treatment cost, Vietnam

INTRODUCTION

Community-acquired pneumonia (CAP), as distinguished from hospital-acquired (nosocomial) pneumonia, is an acute infection of the pulmonary parenchyma in a patient who has acquired the infection in the community.[1,2] There are an estimated 920,000 cases annually, accounting for 16% of deaths among children younger than 5 years old.[2] Lozano *et al.* found that from 1990 to 2010, CAP was ranked as the fourth highest cause of deaths in adults: 1.9 million people over the age of 15 die from CAP each year.[3] Special attention must be paid to CAP in Southeast Asia, where the incidence rate was reported to range between 988 and 4,205 for every 100,000 people in 2016.[4] Indeed, the annual incidence rate of reported infections in Vietnam has been estimated to be between 2.6 and 16.8 cases per 1,000 people annually, with mortality rates of 2–30% for CAP inpatients.[1] In addition, with high morbidity and mortality rates, CAP is considered a growing public health concern because of the accompanying

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significant socioeconomic burden, which includes both direct and indirect costs.[5]

The highest burden comes from hospitalized patients. CAP inpatient care costs accounted for 80–95% of total treatment costs, with the average length of stay (LOS) estimated to be about 9–10 working days.[6] About 8,500 hospitalizations related to CAP annually, at the cost of more than $40 million, were estimated to be in Alberta.[7] Thomas File *et al.* reported that in 2010, the overall economic burden of CAP was estimated to be $9.3 billion for 4 million outpatient cases in the United States (US).[8] Recently, Sato *et al*. estimated the economic burden of CAP to be $11,148–$51,219 per case with an average of 31.8 treatment days. The Chinese Ministry of healthreported the average hospitalization costs of CAP as $575.30–$1,137.40 in 2005.[9,10] Results from studies on Singapore suggest that the inpatient costs for treating CAP varied from $1,294 for 6.4 treatment days to $3,456 for 10 treatment days.[11] In the Philippines, the economic burden associated with CAP was estimated at $852–$5,885 per case.[12]

Studies on Vietnam have described CAP in terms of the clinical picture, diagnosis, treatment, and prevention. However, few studies have assessed the economic burden of CAP, and even fewer have done so for adult inpatients. Estimates of the average treatment cost have varied widely - from $180 to $318 per case in 2014.[13] The lack of data on treatment costs for adult inpatients makes it difficult to evaluate the economic burden of CAP. In this study, the burden of CAP in Vietnam was assessed from a social point of view. In addition, incremental factors related to cost of illness for CAP hospitalized patients were evaluated. Evidence regarding the societal costs of the disease could help policymakers to set priorities, especially in the context of rising health-care costs and to assess a potential effective vaccine.

SUBJECTS AND METHODS

Study design and hospital

From March to May 2017, a cross-sectional study that included a cost-of-illness analysis using a prospective approach and incidence-based measures was conducted on patients who were treated for CAP in the Respiratory Department of Trung Vuong General Hospital in Ho Chi Minh City.[14,15] The focus was the societal perspective. Based on the findings of a study conducted at Bach Mai Hospital in Vietnam in 2016, the sample size was calculated. The mean treatment costs of pneumonia were approximately $318 (SD = 181, CV = 0.5) for 1,000 patients.[13] We used a sample size formula recommended by the World Health Organization in 2005. It had a precision of 5% and assumed a non-response rate of 5% for a sample of 184 pneumonia patients. During three months of data collection, we were able to collect information and analyzed data for 255 patients.[16]

Trung Vuong General Hospital, located in downtown Ho Chi Minh City, is classified as a central level hospital (second highest hospital rank in Vietnam) with 700 beds.[17] Over a 50-year period, Trung Vuong General Hospital had become one of the biggest general hospitals in Ho Chi Minh City by 2014, with a staff of 964 in 27 departments and the capacity for the diagnostic testing and treatment of 1,500–2,000 patients per day.[17] The total number of outpatients and inpatients is more than about 500,000 and 40,000, respectively (unpublished data).

CAP population

Within the framework of the cost-of-illness study, the study cohort comprised all CAP inpatients, identified by enrolment criteria, receiving medical care in the Respiratory Department at Trung Vuong General Hospital from March to May 2017. During the 3 months, the total number of inpatients in the Respiratory Department was 768, and those patients' medical records were reviewed by researchers using the enrolment criteria for the study to determine CAP patients. The study protocol is described in Figure 1. Of the total 768 hospitalized patients who were screened for CAP, 513 were excluded from this study because either they did not meet the enrolment criteria (n = 481) or their approval could not be obtained (n = 32).

Enrolment criteria

At first, the study included patients who had a primary diagnosis of pneumonia, as defined in the World Health Organization's International Classification of Disease, Tenth Revision (ICD-10th) codes J10-J18. The list of ICD-10 codes included influenza resulting from an identified influenza virus (J10.0, J10.1, and J10.8); influenza, virus not identified (J11.0, J11.1, and J11.8); viral pneumonia, not elsewhere classified (J12.0, J12.1, J12.2, J12.3, J12.8, and J12.9); pneumonia resulting from *Streptococcus pneumoniae* (J13); pneumonia resulting from *Haemophilus influenzae* (J14); bacterial pneumonia, not elsewhere classified (J15.0, J15.1, J15.2, J15.3, J15.4, J15.5, J15.6, J15.7, J15.8, and J15.9); pneumonia resulting from other infectious organisms, not elsewhere classified (J16 and J16.8); pneumonia in disease, classified elsewhere (J17.0, J17.1, J17.2, J17.3, and J17.8); pneumonia, and organism unspecified (J18.0, J18.1, J18.2, J18.8, and J18.9).

If a patient developed the disease 48 hours after admission, he or she was classified as having hospital-acquired pneumonia and was excluded. To ensure the integrity of the study, patients who were arbitrarily discharged from hospital (before full recovery) or moved from another hospital to the study site were excluded. The study also eliminated patients who refused to provide their personal information. The payment data related to enrolled patients were collected from the hospital's electronic database after direct interviewing of the patients. These criteria were based on those used in previous studies of CAP and were modified for the local setting.[4]

The enrolment process resulted in a final sample of 255 participants who had CAP during the study period for analysis

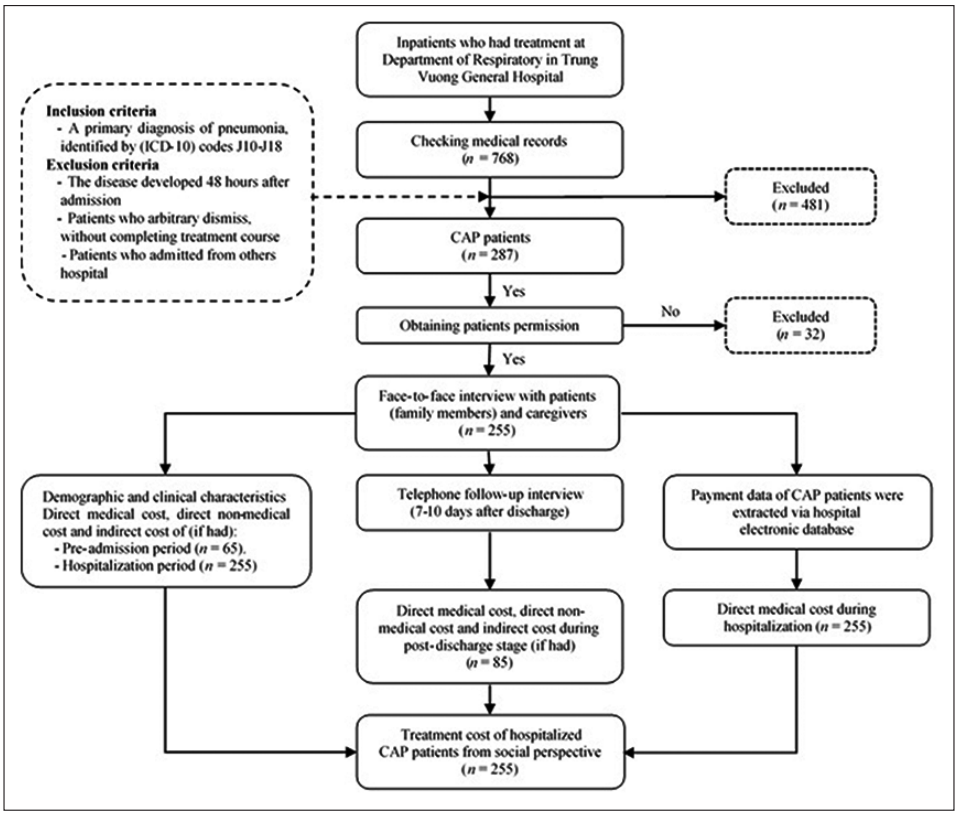

Figure 1: Flowchart of the patients enrolled in this study

of the economic burden of the disease. For the 255 qualified patients, general information and overall treatment costs, including direct medical costs (DMCs), direct non-medical costs (DNMCs), and indirect costs (IDCs), were collected through the following three steps:

Step 1. Questionnaire survey

The survey was conducted at the time of the patient's full recovery from the illness episode by direct interview of the patient using a standardized questionnaire.[18] The survey instrument permitted the collection of demographic information and treatment costs. The general information collected about the participants included age, gender, living place, monthly income, education level, occupation, health insurance status, pneumococcal vaccinations, and LOS. LOS was calculated as number of days between admission and discharge. Clinical symptoms were recorded on admission. They included cough, high fever, shortness of breath, fatigue, headache, and vomiting. The comorbidity of CAP inpatients included pulmonary diseases, cardiovascular diseases, renal diseases, diabetes, digestive system diseases, and cerebrovascular diseases. The examined cost-of-illness data were the DMCs, DNMCs, and IDCs during pre-hospitalization and the DNMCs and IDCs during hospitalization.

Step 2. Extraction direct medical cost data

Payment data were extracted from the hospital electronic data to estimate the DMCs during hospitalization. DMCs included the cost of a bed for each day, diagnostic tests (imaging and laboratory tests), medication, medical supplies, and any surgeries.

Step 3. Telephone follow-up survey

For each case, within 7–10 days after discharge, the interviewers contacted the patient or any family member who had a good knowledge about the CAP illness and the related expenses to ascertain the follow-up costs. The telephone interview (7–10 days after discharge) tended to obtain data, including DMCs, DNMCs, and IDCs, related to the post-discharge period.

In summary, the cohort study required 255 CAP patients to complete two interviews - a face-to-face inpatient interview and a telephone follow-up interview.

Costs associated with CAP

Cost-of-illness in this study refers to the costs incurred from the three stages of treating one CAP episode - cost of treatment pre-hospitalization, hospitalization, and post-discharge.In each stage, treatment costs considered all costs which were estimated from a societal perspective. The costs consisted of direct costs (including DMCs and DNMCs) and IDCs.[19]

Direct cost component

$$\left(\frac{CPI_{2017}}{CPI_{2014}} = 1.549\right)$$

Direct costs consisted of DMCs and DNMCs. Details on resources used were collected from medical records during

hospitalization. These included the cost of diagnostic tests, laboratory tests, bed-days, medication, surgeries, medical supplies, and blood transfusions or infusions. To standardize the reporting of the DMCs, the study based the unit cost of medical services in Vietnam onthat in the study by Vo *et al*. The unit cost of medical services was adjusted for inflation in 2017.[20]

Because of the lack of pre-hospitalization and post-discharge DMCs, the current study focused only on the total DMCs in these stages rather than a detailed analysis of the DMCs. Self-reported illness-related cost items such as meals, transportation, accommodation, as well as informal care costs reported by patients and their family members were considered DNMCs. In addition, the study collected DCs for all three CAP treatment stages - pre-hospitalization, hospitalization, and post-discharge.

Indirect cost component

Indirect costs represent expenses for loss of productivity of patients resulting from hospitalization. This information

Table 1: Demographic and clinical characteristics of CAP inpatients (***n***=255)

Characteristics	Value (%)	Characteristics	Value (%)
Age group (years old)		ICD-10 code	
Mean±SD	66±16	J15	121 (47.5
Median (IQR)	69 (56–78)	J15.1, J15.2, J15.6	15 (5.9)
Range	25–93	J15.9	109 (42.7)
18–44	22 (8.6)	J18	10 (3.9)
45–64	75 (29.4)	Vaccination	
65–74	59 (23.1)	Yes	13 (5.1)
75–84	78 (30.6)	No	242 (94.9)
≥85	21 (8.3)	Health insurance (%)	
Gender		0[a]	32 (12.5)
Male	148 (58.0)	48	14 (5.5)
Female	107 (42.0)	60	11 (4.3)
Length of stay (days)		80	153 (60.1)
Mean±SD	10.3 (5.4)	95	9 (3.5)
Median (IQR)	10 (7–12)	100	36 (14.1)
Range	2–32	Comorbidity	
Living places		Pulmonary diseases	108 (42.4)
Urban	227 (89.0)	Cardiovascular diseases	176 (69.0)
Rural	28 (11.0)	Renal diseases	17 (6.7)
Education level		Diabetes	56 (22.0)
Illiteracy	23 (9.0)	Digestive system diseases	115 (45.1)
Elementary school	67 (26.3)	Cerebrovascular diseases	11 (4.3)
Secondary school	60 (23.5)	Other diseases (gout, etc.)	24 (9.4)
High school	68 (26.7)	Hospitalization Symptoms	
College (2–3 years training)	8 (3.1)	High fever	97 (38.0)
University (4–6 years training)	29 (11.4)	Cough	140 (54.9)
Occupation		Shortness of breath	102 (40.0)
Worker/Labor	32 (12.5)	Fatigue	43 (16.9)
Trader/Businessman	27 (10.6)	Others (headache, vomit, etc.)	66 (25.9)
Housewife	8 (3.1)	History of getting CAP	
Retirement	179 (70.3)	Yes	78 (30.6)
Others[b]	9 (3.5)	No	177 (69.4)

CAP: Community-acquired pneumonia, ICD-10: International Statistical Classification of Diseases and Related Health Problems 10th Revision. [a]Out of pocket, [b]Student, Farmer, Teacher, etc., SD: Standard deviation, IQR: Interquartile range

was obtained during patient interviews. The estimation was based on the number of working days (calculated as 30 per month) lost and the reported monthly income of patients and caregivers. Each working day was assumed to be eight hours. The IDC was calculated by multiplying the mean monthly income by the number of lost working days. In this study, people older than 65 were considered as having low (almost zero) IDCs. Moreover, the reported IDCs in the current study were those for patients. The IDCs to caregivers were combined with the DMCs and DNMCs to caregivers and reported as caregiver costs.

Analytical approaches

The demographic data were analyzed and expressed by frequency, proportion, and mean using Microsoft Excel 2016. The cases were divided into two age groups - adults under 65 and adults (elderly people) over 65. The study estimated the standard deviations (SDs) for the average treatment cost for each age group for each period (pre-hospitalization, hospitalization, and post-discharge) and for each component (DMC, DNMC, IDC, and informal cost). Moreover, the study also assessed differences in treatment costs between the two age groups using a *t*-test assuming unequal variances. In the overall group, cost was calculated and described as the mean with SD, range (with a 95% confidence interval) and proportion (compared with total average cost of treatment). The results for costs were presented in 2017 US dollars ($1 USD = ₫22,433).[21] Descriptive statistics were used to compare the average treatment cost along various dimensions (e.g., gender and living place). Differences in treatment cost per patient were estimated using a *t*-test and ANOVA single factor, as appropriate, through Microsoft Excel 2016. $P < 0.05$ was considered significant in all statistical analyses.

Ethics statement

To avoid any violation of the principles for using human participants set forth in the Declaration of Helsinki, the ethical review committees of Trung Vuong General Hospital reviewed and approved the study protocol, the questionnaire, and the information letter for participants. Case investigations could not reveal the patients' personal information. The patient's privacy and other rights and interests were not violated. All patients or family members who had information about expenses during the disease period (in the case of patients unable to participate in a direct interview), and caregivers participating in this study provided written informed consent.

Table 2: Average expenses divided by pre-hospitalization, hospitalization, and post-discharge periods (USD 2017; ***n***=255)

Age (years)	<65	≥65	*P* value[a]	All ages	*P* value[b]
Pre-hospitalization					<0.01
Direct medical cost	26.3±27.4	50.1±81.7	0.520	37.3±57.5	
Direct non-medical cost	51.5±60.0	60.8±79.9	0.818	10.6±28.2	
Indirect cost	12.5±12.6	-	0.039	6.7±11.0	
Total cost	40.2±18.4	71.5±122.1	0.560	54.7±81.5	
Hospitalization					0.711
Direct medical cost	407.4±458.2	502.2±264.0	0.409	465.0±351.8	
Direct non-medical cost	108.4±152.7	120.4±91.6	0.755	115.7±118.1	
Indirect cost	42.9±52.3	-	0.002	16.8±38.6	
Total cost	558.8±573.6	622.6±301.1	0.651	597.5±424.7	
Post-discharge					<0.01
Direct medical cost	27.1±56.1	13.9±15.1	0.537	20.1±39.2	
Direct non-medical cost	5.7±5.8	12.1±9.9	0.128	9.1±8.7	
Indirect cost	5.7±5.8	-	0.027	22.1±44.6	
Total cost	79.8±84.4	26.0±19.5	0.116	51.3±63.9	
Total					<0.01
Direct medical cost	427.5±455.4	515.9±259.0	0.436	481.2±347.8	
Direct non-medical cost	111.2±154.1	128.0±95.2	0.655	121.4±120.5	
Indirect cost	66.1±82.9	-	0.002	25.9±60.6	
Total cost	604.8±571.0	643.9±297.2	0.779	628.6±421.1	

[a]Comparison of mean cost using *t*-test two-sample assuming unequal variances; [b]Comparison of mean cost among three periods of treating CAP (pre-hospitalization, hospitalization, and post-discharge) using ANOVA single factor. CAP: Community-acquired pneumonia, USD: US dollars

Table 3: Estimated average DMCs per CAP case by component (USD 2017; ***n***=255)

Cost components	Total cost (%)	Mean±SD	95% CI
Direct medical cost			
Medical care cost[a]	827.1 (0.4)	16.2±40.7	5.0–27.4
Imaging technique	8,373.7 (3.9)	32.8±16.4	27.8–37.8
Radiograph	4,789.6 (2.2)	18.8±17.9	13.8–22.9
CT scanner	2,158.5 (1.0)	54.2±14.7	44.2–64.2
Ultrasonic	1,425.6 (0.7)	7.6±5.0	6.0–9.2
Laboratory test	11,950.6 (5.6)	46.9±11.0	43.9–49.9
Serum biochemistry tests	1,602.1 (0.8)	6.3±1.3	5.9–6.7
Urine biochemistry tests	691.0 (0.3)	2.7±1.1	2.4–3.0
Microbiological tests	8,816.4 (4.1)	42±23.1	35.0–49.0
Other tests	841.0 (0.4)	3.3±3.2	2.4–4.2
Bed-day	24,042.7 (11.3)	94.3±54.0	79.5–109.1
Pharmaceutical	66,124.8 (31.0)	259.3±45.4	246,8–271,8
Antibiotics	48,702.1 (22.8)	191.0±74.3	170.6–211.4
Respiratory affected drug	2,967.1 (1.4)	11.6±6.6	9.6–13.6
Analgesic drug	3,112.5 (1.5)	12.2±8.6	9.7–14.7
Other medicines	11,343.1 (5.3)	44.5±22.8	38.2–50.8
Operation	4,411.9 (2.1)	126.1±77.5	68.7–183.5
Medical supplies	2,185.5 (1.0)	8.6±2.9	7.8–3.7
Others	1,491.1 (0.7)	5.8±10.9	2.8–8.8
Direct non-medical cost			
Transport	629.1 (0.3)	12.3±14.6	8.3–16.3
Meal	1,723.8 (0.8)	33.8±29.8	25.6–42.0
Caregiver	3,738.0 (1.8)	73.3±94.9	47.3–99.3
Indirect cost			
Productivity lost	1322.5 (0.6)	25.9±60.6	9.3–42.6
Total	213,269.8 (100.0)	628.6±421.1	513.0–744.0

[a]Direct medical costs for pre-hospitalization and post-discharge periods. SD: Standard deviation, CI: Confidence interval, DMCs: Direct medical costs, CAP: Community-acquired pneumonia, USD: US dollars

RESULTS

Demographic data and clinical presentation

The study comprised 255 patients hospitalized for CAP. Their demographic characteristics, comorbidity, and admission symptoms are reported in Table 1. Fifty-eight percent of all patients were male, and the median age was 69 (ranging from 25 to 93). Sixty-two percent of all patients were elderly people over 65, and 38.9% were over 75. In terms of comorbidity, 69.0% had cardiovascular diseases, 45.1% had digestive system diseases, and 41.4% had pulmonary diseases. A majority of the symptoms on admission were cough (54.9%) and shortness of breath (40.0%).

Cost results

According to the data in Table 2, the total average cost per case was $628.60 ± $421.10. The average cost per case of patients ≥65 years old was higher than for patients <65 years old but not significant ($643.9 ± $297.2 and $604.8 ± $571.0, respectively; $P = 0.779$). The average DMCs, DNMCs, and IDCs per episode were estimated to be $481.20 ± $347.80, $121.40 ± $120.50, and $25.90 ± $60.60, respectively.

The detailed DMCs during hospitalization are described in Table 3 and Figure 2. As can be seen in Figure 2, medications accounted for the highest proportion of the cost (55.8%), 1,191 with the largest proportion (nearly three-quarters (73.6%) attributed to antibiotics.

According to the data in Table 4, the total average informal cost per case was $297 ± $255.30. There was a difference in informal costs between patients under and over 65, but statistical significance was not reached ($P = 0.798$). On the other hand, the study showed that there were differences in terms of indirect, transportation, and meal costs among patients and caregivers ($P < 0.05$). The average CAP treatment costs according to

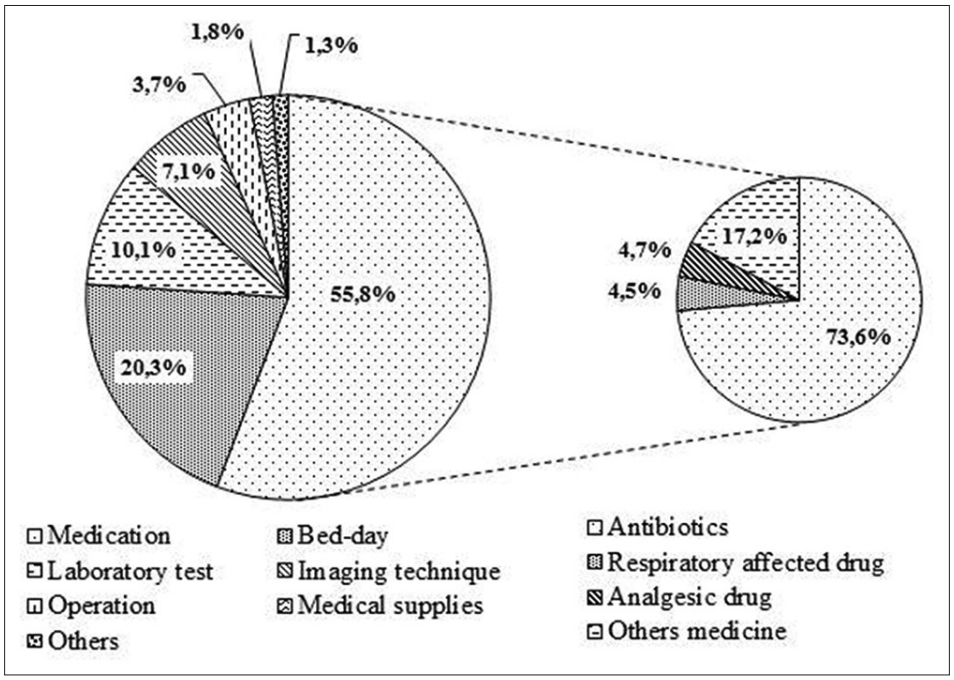

Figure 2: Distribution of direct medical costs during hospitalization

Table 4: Detail of informal costs by patients age (USD 2017; ***n***=255)

Age (years)	<65	≥65	*P* value[a]	All ages	*P* value[b]
Indirect cost					
Caregivers time cost	85.2 (116.2)	46.0 (57.8)	0.287	58.3 (81.3)	0.043
Patients time cost	66.1 (82.9)	-	0.002	25.9 (60.6)	
OOP[c] payments					
Transportation for patients	7.1 (8.1)	15.7 (16.8)	0.018	12.3 (14.6)	0.001
Transportation for caregivers	2.5 (2.8)	5.6 (10.6)	0.124	4.4 (8.5)	
Food for patients	34.1 (40.6)	33.6 (20.9)	0.953	33.8 (29.8)	0.036
Food for caregivers	14.3 (21.7)	27.3 (26.7)	0.063	22.2 (25.4)	
Lodging for caregivers	2.0 (5.0)	4.0 (3.6)	0.130	3.2 (4.3)	
Out of health insurance[d]	131.2 (124.7)	164.9 (184.9)	0.440	151.7 (163.4)	
Total	308.5 (249.9)	289.6 (262.6)	0.798	297.0 (255.3)	

Data were presented as mean (SD) cost in USD. [a]Comparison of mean cost using *t*-test two-sample assuming unequal variances; [b]Comparison of mean cost for three periods of treating CAP (pre-hospitalization, hospitalization, and post-discharge) using ANOVA single factor; [c]Out of pocket (expenses, which were unbudgeted and paid for in cash, relating to DNMC and DMC); [d]Patient's expenses for medical care that were not reimbursed by insurance (including deductibles, coinsurance, and copayments for covered services plus all costs for services that were not covered). SD: Standard deviation, DMCs: Direct medical costs, CAP: Community-acquired pneumonia, UDS: US dollars, DNMC: Direct non-medical costs

patient age, gender, history of CAP, ± living place, LOS, and comorbidities are described and compared in Table 5. A positive correlation was found between LOS and total cost of illness, i.e., the longer the LOS and the greater the cost. The mean cost of treatment for patients whose LOS was <7 days, 7–14 days, and more than 14 days was $325, $652, and $1,191, respectively.

DISCUSSION

The current study found that the average age of patients was 66 ± 16 and that a majority of patients (62.0%) were over 65. This figure was, in fact, similar to that in a study recently conducted in Vietnam in which the mean age was 62.5, with patients over 60 accounting for more than half (56.9%).[22] Another study conducted in Spain in 2007 also obtained similar results, with the mean age being 70 ± 15, and the incidence of CAP for male patients being higher than that for female patients (58.0% compared to 42.0%).[5] In a study conducted in Kien An hospital, the number of male patients was higher than that of female patients (65.9% compared to 34.1%), and the number of urban patients was higher than that of rural patients (89.0% compared to 11.0%).[22] Similar results were also found by Chau *et al.* (55.6% compared to

Table 5: Treatment costs according to patient age, gender, history of CAP, comorbidity, and length of stay (USD 2017; ***n***=255)

Independent variables	Mean±SD (95%CI[b])	*P* value[a]
Gender		
Male	584±319 (466–702)	0.408
Female	688±525 (474–902)	
Age (years)		
<65	607±573 (357–857)	0.779
≥65	647±298 (542–752)	
History of CAP		
Yes	655±294 (507–803)	0.762
No	621±470 (468–774)	
Resident		
Urban	622±418 (502–742)	0.717
Rural	713±513 (265–1,161)	
ICD-10[c] code		
J15	584±316 (462–705)	0.284
J15.1; J15.2; J15.6	974±299 (635–1,312)	
J15.9	670±537 (434–905)	
J18	284±184 (29–538)	
Comorbidity		
Pulmonary disease	578±281 (461–695)	0.205
Cardiovascular disease	609±447 (463–755)	
Renal disease	439±169 (249–629)	
Diabetes	495±172 (383–607)	
Digestive system disease	728±543 (511–945)	
Cerebrovascular disease	377±182 (125–629)	
Other diseases	1158±1116 (68–2,248)	
Number of comorbidities		
None	546±263 (315–777)	0.632
One	613±439 (365–861)	
Two	666±200 (568–764)	
Three	682±600 (388–976)	
Four or more	200±66 (108–292)	
LOS (days)		
<7	325±208 (189–461)	<0.01
7–14	652±174 (594–710)	
>14	1191±857 (553–1,829)	

[a]t-test two-sample assuming unequal variances/ANOVA single factor; [b]Confidence interval; [c]International Statistical Classification of Diseases and Related Health Problems 10th Revision. CAP, community-acquired pneumonia, LOS: Length of stay, SD: Standard deviation, CI: Confidence intervals, USD: US dollars

44.4%) and Reyes *et al.* (59.4% compared to 40.6%).[5,23]

In the current study, pulmonary and cardiovascular diseases were the most frequent comorbidities in CAP patients, and this phenomenon was described by Soraya Azmi *et al*.[4] The current study obtained similar results to those in a study by Reyes *et al*. in which the rate of cardiovascular disease accounted for the highest proportion (32.8%) with regard to comorbidities.[5] In terms of CAP symptoms, this study showed that cough, shortness of breath, and high fever had the highest rates in all patients - 54.9%, 40.0%, and 38.0%, respectively. This is similar to previous reports for Vietnam, i.e. cough, shortness of breath, and high fever accounted for a high proportion of comorbidities: 65.3%, 51.4%, and 62.3%, respectively.[22]

Similarly, LOS per episode was estimated in this study to be 10.3 days, which was identical to other results (7–14 days) obtained in Vietnam.[22] The average LOS in this study was much higher than was previously reported in Malaysia, Indonesia, and the Philippines (6.1–8.6 days) in 2016 and was similar (4–12 days) to that of a study conducted in North America in 2010.[4,8]

This prospective incidence-based study, conducted from March to May 2017 at Trung Vuong General Hospital, resulted in the successfully calculated treatment cost of CAP. The average social cost of treating one hospitalized patient with CAP was $628.6 ± $421.1, which was very similar to results from other studies in the Philippines ($852–$2,678)[12] and lower than those in rural Thailand, where the mean treatment cost ranged between $490 and $628.[24] In Europe, the average treatment cost was much higher. In 2002, the median cost for patients hospitalized with CAP in Spain was estimated to be €1,210, €1,553, or €1,683 (€1,291–€2,471).[5,25,26] The direct costs were €1,333 in Germany and €2,550–€7,650 in the United Kingdom.[27,28] The mean treatment cost per episode LOS <7 days ($325) and >14 days ($1,191) was lower when compared with the average treatment cost in Singapore, which was $1,294 for a hospital stay of 6.4 days and $3,456 for a hospital stay of 10 days.[11] The current study also found the average direct cost per case to be $602.60, which was much lower than that for North America ($3000–$13,000).[8] Gender, CAP history, living place, and comorbidities were examined but were not significantly related to the unequal mean treatment cost. A study conducted in Spain yielded similar results where age, gender, and comorbidities were not significantly associated with a high cost for CAP.[5] The study showed that the mean informal cost per case was $297 ± $255.30. There was a difference in informal costs between patients under and over 65 who needed more care, but statistical significance was not reached (P = 0.798). The ANOVA single factor test was conducted to distinguish between these groups to determine whether significant differences in cost of treatment existed.

There were several limitations to the current study. First, the sample comprised only adult patients because of the characteristics of the selected hospital; consequently, this

study showed the treatment cost of adults only and lacked the data for fully assessing the economic impact of CAP. A larger and more accurate sample in a future study would allow decision makers to better account for CAP costs, particularly for the poor, when balancing the benefits of introducing a potentially effective CAP vaccine. Second, the study depended on physician decisions regarding the diagnosis of CAP, based on the ICD-10 codes assigned at admission. Misdiagnoses could have caused inaccuracies in sample selection. Finally, the calculation of the unit cost was based on that used in a study by Vo *et al*., the data in which could have contained some biases, although this was not critical.[29]

CONCLUSION

This cost-of-care study of adult inpatients suggests that a considerable socioeconomic burden is caused by CAP, which is a preventable disease. To reduce the overall burden of CAP, a pneumococcal vaccine needs to be developed; hence, several vaccine candidates are currently on the market. To perform an analysis of the cost-effectiveness of the potential use of pneumococcal vaccines and other control methods, a more accurate evaluation of CAP and the costs to the public and private sectors in Vietnam for hospitalized and non-hospitalized cases is needed urgently. Such results can be the foundation for formulating investment plans and allocating funds for the treatment and control of this disease.

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