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Original Article

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# Economic Analysis of Hospitalised Paediatric Community-Acquired-Pneumonia at a Private Hospital in Southern Vietnam, Fiscal Year 2015-2016

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## ABSTRACT

**Introduction:** Community-Acquired Pneumonia (CAP) is a commonly occurring serious disease causing substantial morbidity and mortality worldwide. Various studies of treatment costs for CAP cases indicate that it presents a heavy economic burden to society.

**Aim:** The present study was conducted to estimate the direct medical costs for CAP treatment at a private hospital in Southern of Vietnam.

**Materials and Methods:** A retrospective, prevalence-based study was conducted using the electronic medical records database from the hospital to calculate direct medical costs of hospitalised paediatric (under 18-year-old) cases (ICD-10 code J10-J18) based on hospital, healthcare payer and patient perspectives from January, 2015 to December, 2016.

**Results:** There were 855 patients (males accounted for 54.7%) suffering from CAP in the period 2015–2016, with an average age of 10.8±1.8 years. Patients stayed at hospital an average of 6.5±5.5 days. The average treatment cost per case was ₫VND 40 million and hospital beds accounted for the highest proportion of the total costs (41.5%). The total economic burden caused by CAP in the private hospital from 2015 to 2016 was over ₫VND 34.1 billion.

**Conclusion:** CAP is a high-burden disease that should receive more attention in treatment and prevention. The findings of this study give policy makers more evidence confirming the high treatment cost of CAP in the Vietnamese context.

**Keywords:** CAP, Cost of illness, Direct medical cost, Economic analysis

## INTRODUCTION

CAP is defined as an acute pulmonary parenchymal infection in a patient who is not hospitalised or who is residing in a long-term care facility for 14 or more days before onset of symptoms. It is distinguished from Hospital-Acquired Pneumonia (HAP) [1,2]. Viruses are the most important factor causing pneumonia in infants, whereas older children are infected by bacteria such as *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Staphylococcus aureus* [3,4].

CAP is a frequently occurring serious disease associated with significant morbidity worldwide [5]. In the US, it affects a large percentage of senior citizens every year, leading to 600,000 hospitalisations and 59,000 deaths [6]. The World Health Organisation (WHO) estimated that 920,000 infections occur annually, causing about 16% of the total deaths among children under five-year-old [7]. Southeast Asia should take a closer look at CAP, due to a high incidence of this disease, which has increased from 988 to 4,205 per 100,000 persons in 2016 [8]. According to the annual report of the Ministry of Health of Vietnam in 2014, 4,000 children per year under the age of five die because of CAP [9].

The high morbidity and mortality makes CAP a disease with a large economic burden imposed by both direct and indirect costs. Various studies have been runing to estimate CAP treatment costs, which are extremely diverse: 17 billion US dollar (US$) anually in US [5]; 20 million Australia dollar (A$) per year in Australia [10]; 63 million New Zealand dollar (NZ$) per year in New Zealand (NZ$29 million for direct medical cost, NZ$1 million for direct non-medical costs and NZ$ 33 million due to productivity losses) [11]; US$ 2,160- US$ 5,770 per case in Singapore [12]; US$ 575.3-US$ 1,137.4 per case in China [13]. US$ 852 and US$ 5,885 per case in Phillipines [14]. Nevertheless, information on the CAP burden in Vietnam is limited. Only two studies have been focused on this area, one in Khanh Hoa General Hospital (2010) and one in Bach Mai Hospital in Hanoi (2014) [15,16]. Due to the lack of data for treatment costs among CAP patients, especially in southern Vietnam, widening the CAP economic burden evaluation is a worthwhile endeavour.

This study was conducted in a private hospital in Ho Chi Minh City with the aim of offering policy-makers and clinicians more information on direct medical costs among child patients suffering from CAP in the fiscal year 2015-2016. The estimated economic burden of CAP to society in this study will give decision-makers a better understanding of appropriate policies to implement, as well as practical healthcare interventions.

## MATERIALS AND METHODS

### Study Location and Hospital Profile

The site of this study, located in Ho Chi Minh City, was a private hospital that is 100% foreign-owned by a Hong-Kong parent company. The study was conducted in three months from May to August 2017 under the approval by the private hospital (No. 139/2017/HDDD-NCKH) to ensure that all information served only for research purposes. During all data collection, each patient were identified anonymously by creating alphanumeric codes.

### Study Design

In this study, a retrospective database analysis was conducted using a private hospital electronic medical records database to determine the direct medical cost of CAP hospitalisation cases between 2015 January and 2016 December. Regarding the perspectives, this Cost-Of Illness (COI) study was carried out from patients, healthcare payer, and hospital perspective.COI has been defined as a range of aspects of the disease impact on the health outcomes in a country, regions, communities and individuals [17].

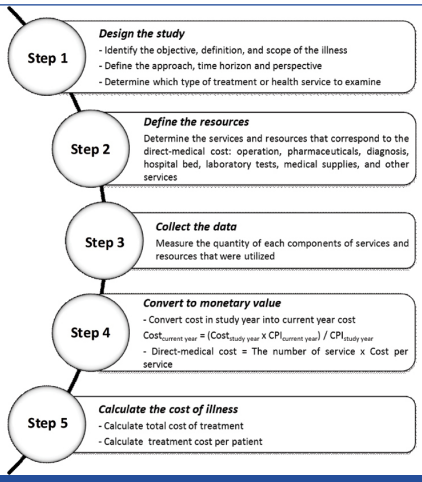
### Study Population and Data Collection

Data were extracted from the hospital electronic database after receiving ethical approval from the hospital. All paediatricin patients

diagnosed with CAP were included into the research. The concepts of "paediatric" or "child/children" in this study are based on the definition of United Nations Convention on the Rights of the Child. Thereby, "child" was defined as a human being below the age of 18 years [18]. The International Classification of Disease 10th Edition (ICD-10) code J10-J18 was used during the selection window [19]. Patients who had missing information or errors in the information entered into the electronic database, or had been discharged from the hospital without certification was eliminated.

## Estimating Cost

Analysing the cost of a certain illness followed a five-step process [20], as demonstrated in [Table/Fig-1].




**[Table/Fig-1]:** Five-step process for analysing cost of treatment.

The direct medical costs related to CAP patients are estimated by combining healthcare use data, including the costs of operation, pharmaceuticals, diagnostics, hospital beds, laboratory tests, medical supplies, and other services. Since the hospital had no standard unit cost for medical services, a reference unit cost was used to estimate the costs of medical services [21]. All costs were converted into the current year using the Consumer Price Index (CPI) values [22], and were eventually presented in the local currency, the Vietnam dong (₫VND); the average exchange rate in June 2017 was US$1=₫VND22,399 [23].

## Study Approach

The approach taken is an essential part of a COI study. Based on the collection of epidemiological data, two common methods are employed: incidence and prevalence based. The former approach is useful in estimating treatment costs for a long-duration disease, from the first appearance of symptoms until the patient's death or cure. Conversely, the main approach adopted was the prevalence-based approach estimates the burden of a condition over a specific period, usually a year [17].The time horizon of this study was set at one year to avoid seasonal variations and patients showing symptoms before or during the time horizon [20].

## Data Analysis and Presentation

The hospital database was divided into two categories: demographic characteristics and treatment cost. For the demographic information, the following variables were considered: age, gender, length of stay, insurance rate and diagnosis (ICD-10 code). The treatment cost was analysed by calculating resource utilisation (pharmaceuticals and supplies, laboratories, diagnostic examinations, hospital beds, procedures and hospital charges).

Data were managed and analysed using the Microsoft Excel 2013 statistical software for Windows. Resource consumption and direct medical costswere described with Standard Deviation (SD).

# RESULTS

## Characteristic of the Study Participants

[Table/Fig-2] shows an overview of the demographic characteristics of the included patients from 2015 to 2016. The age of pneumonia patients was 10.5±1.6 in 2015, with a slight increase in age to 11.6±2.1 in 2016. Overall, the number of male patients was approximately equal to the number of female patients in 2015–2016, although a large difference became apparent in 2016 when comparing these two figures. The diseases coded J15 had an overwhelming percentage of patients, at 98.7% (n=844), whereas J18 accounted for 1.3% (n=11). The results about length of stay throughout the two years were nearly stable, and 100% of the patients who were eligible in this study had no applicable health insurance.

| Characteristic | 2015 a (n=461) | 2016 a (n=394) | 2015–2016 a (n=855) |
|---|---|---|---|
| Age (years) | | | |
| Mean±SD | 10.5±1.6 | 11.6±2.1 | 10.8±1.8 |
| Gender | | | |
| Male, n (%) | 220 (47.7) | 248 (62.9) | 468 (54.7) |
| Female, n (%) | 241 (53.3) | 146 (37.1) | 387 (45.3) |
| ICD-10b | | | |
| J15, n (%) | 453 (98.3) | 391 (99.2) | 844 (98.7) |
| J18, n (%) | 8 (1.7) | 3 (0.8) | 11 (1.3) |
| Length of stay (days) | | | |
| Mean±SD | 7.0±6.6 | 6.0±4.2 | 6.5±5.5 |
| Median (Interquartile range) | 6 (4-7.5) | 6 (3-6.25) | 6 (4-7) |
| Range (Min-Max) | 2-34 | 2-23 | 2-34 |

**[Table/Fig-2]:** Demographics of the included patients between 2015 and 2016 at the private hospital (n=855).
[a]Data was presented in each year 2015, 2016, and the total during two years.
[b]J15: Bacterial pneumonia; J18: Pneumonia, organism unspecified

## Estimated Economic Burden of CAP

From the hospital perspective, [Table/Fig-3] gives a thorough presentation of the components of total treatment costs of CAP between 2015 and 2016 at the private hospital. Eight components recommended were the costs of operations, pharmaceuticals, physicians' diagnoses, imaging techniques, hospital beds, laboratory tests, medical supplies and other services. The survey lasted for two years, with 461 patients in 2015 and 394 participants in 2016. The large decrease in the number of patients was relative to the distribution of cost components.

As shown in [Table/Fig-3], almost all of the cost components diminished from 2015 to 2016. The average treatment cost per case was ₫VND 43,061,206 in 2015 and this decreased to ₫VND 36,250,450 in 2016. However, medical supplies had a slight increase and the laboratory costs in 2016 were four times higher than in 2015. In detail, the highest proportion of total costs in 2015 was the cost of hospital beds, which accounted for 43.7% of the total costs, whereas this item ranked second in 2016 at 38.3%, which was lower than the physician costs,at 40.1% in 2016. However, based on the general statistic for the two years, the cost of hospital beds still ranked first, at 41.5% (₫VND 14,154,027,459) and the physician cost ranked second,at 35.7% (₫VND 12,202,141,238). Other costs were minuscule in comparison, including the costs of operations (9.0%), pharmaceuticals (10.0%), imaging techniques (1.0%), laboratory tests (0.8%), medical supplies (0.7%) and other service utilisation (1.3%).

[Table/Fig-4] presents the costs of medical services for CAP treatment in the years 2015 and 2016. Medical services included pharmaceuticals, imaging techniques, laboratory tests, physician, operation, bed-day medical supplies and other service utilisation cost. Overall, the bed-day, physician diagnosis and pharmaceuticals clearly accounted for the largest costs in both years. The costs of

| Cost components | 2015 (n=461) | 2016 (n=394) | 2015-2016 (n=855) |
|---|---|---|---|
| Operation | 1,774,892,492 (8.9) | 1,297,661,410 (9.1) | 3,072,553,902 (9.0) |
| Pharmaceutical | 2,333,775,837 (11.8) | 1,092,703,301 (7.7) | 3,426,479,138 (10.0) |
| Physician | 6,474,704,639 (32.6) | 5,727,436,600 (40.1) | 12,202,141,238 (35.7) |
| Image techniques | 209,231,298 (1.1) | 147,498,297 (1.0) | 356,729,595 (1.0) |
| Hospital bed | 8,681,322,033 (43.7) | 5,472,705,426 (38.3) | 14,154,027,459 (41.5) |
| Laboratory | 50,610,545 (0.3) | 217,503,826 (1.5) | 268,114,371 (0.8) |
| Medical supplies | 111,313,378 (0.6) | 114,379,328 (0.8) | 225,692,706 (0.7) |
| Other service utilisation | 215,365,949 (1.1) | 212,788,990 (1.5) | 428,154,939 (1.3) |
| Total treatment cost | 19,851,216,172 (100.0) | 14,282,677,178 (100.0) | 34,133,893,350 (100.0) |
| Average treatment cost per case (±SD) | 43,061,206 ± 1,284,431 | 36,250,450 ± 1,270,398 | 39,922,682 ± 1,277,415 |

**[Table/Fig-3]:** Economic burden of CAP between 2015 and 2016 from hospital perspective (₫VND (%), 2017).

most services fell between 2015 and 2016, except for costs of laboratory tests and medical supplies, which rose. Considering the pharmaceuticals, decreases in the number of antibiotics, drugs affecting the respiratory system, analgesic drugs and others led to a cost savings for CAP treatment (from ₫VND 2,333,775,837 in 2015 down to ₫VND 1,092,703,301 in 2016). Antibiotics accounted for the largest percentage of both number and cost in pharmaceutical services in both years. A decline in imaging techniques and operation costs was also noted, but the cost of laboratory tests significantly increasedover four fold, from ₫VND 50,610,545 (2005) to ₫VND 217,503,826 (2016). In 2015, the bed-day was the mostcostly service (₫VND 8,681,322,033); however, physician costs became the leading costservice one year later (₫VND 5,727,436,600) although the costs of both these services declined in 2016 compared to 2015. Despite the rise in cost of medical supplies, this service turned out to be the least costly in 2016 (₫VND 114,379,328).

[Table/Fig-5] displays the figures for each kind of drug prescribed in the private hospital from 2015 to 2016. The cost for drugs was ₫VND 3,426,479,138 for 855 patients. Comparison of the figures in 2015 and 2016 revealed aclear distinction that the treatment costs in 2015 were ₫VND 1,241,072,536 greater than in 2016. Regarding drugs per prescription, the numbers for 2015 and 2016 showed

| Characteristic | 2015 (n = 461) | | 2016 (n=394) | | 2015-2016 (n=855) | |
|---|---|---|---|---|---|---|
| | No. (%) | Cost (%) | No. (%) | Cost (%) | No. (%) | Cost (%) |
| Pharmaceutical | 40,776 (100,0) | 2,333,775,837 (100.0) | 31,299 (100.0) | 1,092,703,301 (100.0) | 72,075 (100.0) | 3,426,479,138 (100.0) |
| Antibiotics | 12,675 (31.1) | 1,507,404,973 (64.5) | 9,253 (29.6) | 609,925,203 (55.8) | 21,928 (30.4) | 2,117,330,176 (61.8) |
| Beta-lactama | 10,274 (81.1) | 1,034,333,196 (68.6) | 8,132 (87.9) | 416,889,819 (68.4) | 18,406 (83.9) | 1,451,223,015 (68.5) |
| Macrolideb | 474 (3.7) | 107,690,488 (7.1) | 366 (4.0) | 67,169,470 (11.0) | 840 (3.8) | 174,859,958 (8.3) |
| Peptidec | 1,141 (9.0) | 203,287,105 (13.5) | 395 (4.3) | 49,681,296 (8.1) | 1,536 (7.0) | 252,968,400 (11.9) |
| Quinoloned | 557 (4.4) | 147,150,031 (9.8) | 286 (3.1) | 68,722,572 (11.3) | 843 (3.8) | 215,872,603 (10.2) |
| Other antibiotic groupse | 229 (1.8) | 14,944,153 (1.0) | 74 (0.8) | 7,462,047 (1.2) | 303 (1.4) | 22,406,200 (1.1) |
| Generic drug | 8,747 (69.0) | 952,157,053 (63.2) | 6,555 (70.8) | 377,872,612 (62.0) | 15,302 (69.8) | 1,330,029,665 (62.8) |
| Brand name drug | 3,928 (31.0) | 555,247,920 (36.8) | 2,698 (29.2) | 232,052,091 (38.0) | 6,626 (30.2) | 787,300,511 (37.2) |
| Drugs affect the respiratory systemf | 14,212 (34.9) | 302,507,124 (13.0) | 10,780 (34.4) | 180,485,454 (16.5) | 24,992 (34.7) | 482,992,578 (14.1) |
| Analgesic drugsj | 2,515 (6.2) | 209,373,416 (9.0) | 1,857 (5.9) | 111,998,147 (10.2) | 4,372 (6.1) | 321,371,563 (9.4) |
| Other groups | 11,374 (27.9) | 314,490,324 (13.5) | 9,409 (30.1) | 190,294,497 (17.5) | 20,783 (28.8) | 504,784,821 (14.7) |
| Image techniques | 460 (100.0) | 209,231,298 (100.0) | 320 (100.0) | 147,498,297 (100.0) | 780 (100.0) | 356,729,595 (100.0) |
| Radiographs | 358 (77.8) | 182,654,424 (87.3) | 286 (89.4) | 142,851,820 (96.8) | 644 (82.6) | 325,506,244 (91.2) |
| CT Scanner | 17 (3.7) | 12,229,065 (5.8) | 2 (0.6) | 1,029,830 (0.7) | 19 (2.4) | 13,258,894 (3.7) |
| Ultrasonic | 85 (18.5) | 14,347,809 (6.9) | 32 (10.0) | 3,616,648 (2.5) | 117 (15.0) | 17,964,457 (5.0) |
| Laboratory test | 3,160 (100.0) | 50,610,545 (100.0) | 2,772 (100.0) | 217,503,826 (100.0) | 5,932 (100.0) | 268,114,371 (100.0) |
| Biochemistry tests | 666 (21.1) | 6,158,193 (12.2) | 608 (21.9) | 17,293,922 (8.0) | 1,274 (21.5) | 23,452,115 (8.7) |
| Microbiological tests | 904 (28.6) | 15,055,769 (29.7) | 800 (28.9) | 44,116,740 (20.3) | 1,704 (28.7) | 59,172,509 (22.1) |
| Other tests | 1,590 (50.3) | 29,396,583 (58.1) | 1,364 (49.2) | 156,093,164 (71.8) | 2,954 (49.8) | 185,489,748 (69.2) |
| Physician | 7,782 (100.0) | 6,474,704,639 (100.0) | 6,080 (100.0) | 5,727,436,600 (100.0) | 13,862 (100.0) | 12,202,141,238 (100.0) |
| Operation | 2,954 (100.0) | 1,774,892,492 (100.0) | 2,134 (100.0) | 1,297,661,410 (100.0) | 5,088 (100.0) | 3,072,553,902 (100.0) |
| Bed-day | 2,815 (100.0) | 8,681,322,033 (100.0) | 2,058 (100.0) | 5,472,705,426 (100.0) | 4,873 (100.0) | 14,154,027,459 (100.0) |
| Medical supplies | 569 (100.0) | 111,313,378 (100.0) | 964 (100.0) | 114,379,328 (100.0) | 1,533 (100.0) | 225,692,706 (100.0) |
| Other service utilization cost | 817 (100.0) | 215,365,949 (100.0) | 514 (100.0) | 212,788,990 (100.0) | 1,331 (100.0) | 428,154,939 (100.0) |

**[Table/Fig-4]:** Cost of medical services between 2015 and 2016 (₫VND (%), 2017).
[a]: Ceftriaxone, Cefixime, Meropenem, Ceftazidime, Cefoperazone+Sulbactam, Cefamandole, Amoxicillin+Clavulanic acid, Amoxicillin+Sulbactam, Imipenem, Ertapenem, Piperacillin+Tazobactam, Cefetamet, Cefpirome, Ampicillin+Sulbactam, Ticarcillin+Potassium clavulanate, Cefuroxime, Sultamicillin, Cefepime, Cefmetazole; [b]: Clarithromycin, Azithromycin;
[c]: Vancomycin, Colistin;d: Levofloxacin, Ciprofloxacin, Moxifloxacin; [e]: Metronidazole, Fosfomycin, Nystatin, Linezolid, Clindamycin, Amikacin, Tobramycin; [f]: Salbutamol, Theophylline, Fenoterol+Ipratropium, Bromhexine, Salmeterol+Fluticasone propionate, Budesonide+Formoterol, Terbutaline, Acetylcysteine, Tiotropium, Terpin+Codeine; [j]: Methyl prednisolone, Budesonide, Fentanyl, Hydrocortisone, Paracetamol, Meloxicam, Paracetamol+Tramadol, Prednisolone, Paracetamol+Codeine phosphate, Pethidin, Diclofenac, Piroxicam, Morphine sulfate, Celecoxib, Etoricoxib

| Drug usage | 2015 | | 2016 | | 2015-2016 | |
|---|---|---|---|---|---|---|
| | No. | Cost (±SD) | No. | Cost (±SD) | No. | Cost (±SD) |
| Number of drug | 160 | 2,333,775,837 | 155 | 1,092,703,301 | 315 | 3,426,479,138 |
| Number of patient | 461 | | 394 | | 855 | |
| Drug per prescription | 4.56 | 5,062,420 (882,370) | 4.59 | 2,773,359 (518,450) | 4.57 | 3,993,565 (700,410) |
| Antibiotic per prescription | 1.18 | 3,269,859 (950,732) | 1.15 | 1,548,034 (462,875) | 1.17 | 2,467,751 (706,804) |
| Beta-lactam | 0.85 | 2,243,673 (859,936) | 0.91 | 1,058,096 (388,109) | 0.88 | 1,691,402 (594,307) |
| Macrolide | 0.09 | 440,970 (3,220,998) | 0.04 | 170,481 (143,303) | 0.07 | 294,835 (1,464,155) |
| Peptide | 0.07 | 319,197 (617,394) | 0.14 | 126,095 (193,267) | 0.10 | 251,600 (426,664) |
| Quinolone | 0.13 | 233,602 (188,521) | 0.05 | 174,423 (62,073) | 0.09 | 203,799 (128,509) |
| Other antibiotic groups | 0.04 | 32,417 (1,361,514) | 0.01 | 18,939 (40,245) | 0.03 | 26,114 (711,552) |
| Other drug per prescription | 3.38 | 1,792,562 (1,006,158) | 3.44 | 1,225,325 (658,175) | 3.41 | 1,525,815 (723,623) |

**[Table/Fig-5]:** Structure of drugs using in a prescription from 2015 to 2016 (₫VND, 2017).

no significant differences, at 4.56% and 4.59%, respectively. However, the average cost for prescription drugs in 2015 was ₫VND 5,062,420±882,730, which was almost double (1.83 times) the cost in 2016. In this study, among prescription drugs, antibiotics were conspicuous (1.18 drugs per prescription in 2015 and 1.15 drugs per prescription in 2016) due to their largest cost (₫VND 2,467,751±706,804). Remarkably, beta-lactam was prescribed at the highest proportion (0.88 drugs per prescription) and cost ₫VND 1,691,402±594,307. The number of drugs per prescription of macrolide, peptide or other antibiotic groups (except from beta-lactam, macrolide, peptide and quinolone) was under 0.1.

## DISCUSSION

The results presented here showed a mean age for children patients suffering from CAP of 10.8±1.8 years. However, comparison of this number with other studies over the world is inappropriate due to the differences in study populations.The 855 patients in the present study had a higher proportion of males than females, at 54.7% and 45.3% respectively. This result is similar to the studies in Spain [24] (63.9% male patients), China [25] (61.0%) and Vietnam [26] (65.9%), but is opposite to results from Australia [10] (45.0%) and US [6] (42.0%). When compared to foreign studies, the number of days spent in hospital was smaller in this study, at 10.8±1.8 days compared to13.0±17.0 days from the study by Gil-Prieto R et al., in Spain [24] and 12.0 days from study by Zhou Q-T et al., in China [25]. Previous COI studies in Vietnam, however, gave different results. Patients included in the study by Quyen BT [27] stayed 8.4 days in hospital and the treatment duration in Bach Mai Hospital in 2014 claimed by Phuc Le et al., was only 6.1 days [16]. The results of this cost analysis showed that CAP imposed a high economic burden in the two-year period 2015-2016 (₫VND 34,133,893,350), with the highest cost for hospital beds (₫VND 14,154,027,459). The mean treatment cost per patient was ₫VND 39,922,682±21,277,415. To simplify the comparison with other studies, the findings were transformed into US$ (US$1 = ₫VND 22,399). The total treatment cost for 855 hospitalised paediatric CAP patients in the private hospital was therefore US$ 1,523,903 and the cost per case was US$ 1,782±950. These numbers were substantially larger than those from previous COI studies in Vietnam; for example, the average treatment cost in Paediatric Nam Dinh Hospital estimated by Quyen BT [27] was only US$61.6 and the cost in Bach Mai Hospital calculated by Phuc Le et al., was US$318 [16]. Treatment costs in the private hospital were even higher than those reported in other studies around the world:US$235 in Pakistan [28], US$177 in Kenya [29], US$215 in Zambia [30], and US$147 in India [31], excepting for 1,631 Euro (US$ 1,920) in Turkey [32].

## LIMITATION

The findings from this study should be interpreted in light of several limitations. First, average treatment costs were estimated in a private hospital and hence are likely to be skewed and not representative of the whole country. Second, this study only concentrated on direct medical costs, while direct non-medical costs and indirect costs are crucial components that can cause a high economic burden. Last but not least, since the study site was a private hospital, the treatment costs were out-of-pocket for the patients; therefore, the vital role of the third-payer in the healthcare system was regrettably ignored. Future studies should widen the scope nationally and analyse the whole structure of costs, as well as evaluate how effective the health insurance policy works.

## CONCLUSION

CAP places a heavy burden on the national economy, as partly shown by the direct medical costs at a private hospital in southern Vietnam. The most effective way to reduce the costs of CAP treatment is to prevent contact with the infectious factor, which would be a benefit of vaccination. The study findings will provide researchers and policy makers with useful information in order to prioritise resources for CAP treatment and prevention.

## ABBREVIATIONS

A$ Australia dollar; CAP Community-acquired pneumonia; COI Cost of illness; CPI Customer Price Index; ED Emergency Department; FDA Food and Drug Administration; GDP Gross Domestic Product; HAP Hospital-acquired pneumonia; HCMC Ho Chi Minh City; ICD-10 The International Classification of Disease 10th Edition; NZ$ New Zealand dollar; PCV7 Seven-valent pneumococcal conjugate vaccine; PPV23 Pneumococcal polysaccharide vaccine; SD Standard deviation; US United State; US$ US dollar; ₫VND Vietnam dong; WHO World Health Organisation.

## DISCLOSURE

The Authors declare that they have no relevant conflicts of interest to disclose.

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