

## Observational Study

# Economic burden for management of community-acquired pneumonia in children below 5 years in India

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For reporting direct and indirect costs for managing community-acquired pneumonia (CAP) in children <5 years in India, we reviewed medical records of 532 children with respiratory conditions hospitalized in public hospital (PBH) and private hospital (PVH) between 2012 and 2014. Inpatient costs were estimated from discharge records; outpatient costs were estimated using physician and parent surveys. Cost analysis was performed in 169 children with CAP (PVH: 102 [60.35%]; PBH: 67 [39.64%]). Mean duration of hospitalization was shorter in PVH than in PBH (5.87 versus 7.97 days). Average per-episode hospitalization cost was almost 7 times higher in PVH than in PBH. Mean outpatient direct and indirect costs were 10,688 (\$148) and 9,286 (\$129). Sick-time costs in PVH and PBH were 9,286 (\$129) and 3,118 (\$43). High costs of CAP management are attributed to hospitalization and diagnostic test costs. Pneumococcal vaccination may reduce these costs.

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**Key words :** Community-acquired pneumonia, cost analysis, under 5 children.

Pneumonia is the single largest cause of infection-related deaths in children worldwide, accounting for 16% of all deaths in children <5 years old (under 5)<sup>1</sup>. Community-acquired pneumonia (CAP) is most frequently caused by *Streptococcus pneumoniae*, followed by *Haemophilus influenzae* and *Mycoplasma*, *Chlamydia*, and *Legionella spp*<sup>2</sup>. Farooqui *et al* estimated 3.6 million episodes of severe pneumonia and 0.35 million pneumonia deaths in under 5 in 2010 in India<sup>3</sup>. CAP frequently causes hospitalization in under 5 in India<sup>4</sup>.

Pharmacotherapy includes oral antibiotics such as macrolides (azithromycin) or  $\beta$ -lactams (amoxicillin) for outpatients without comorbidities for 5 days. Hospitalized patients in non-intensive care units (ICUs) are recommended a  $\beta$ -lactam (cefotaxime, ceftriaxone, or amoxicillin-clavulanic acid) plus a macrolide for 7 days. Treatment can be continued depending on etiologic agents and comorbidities<sup>5</sup>.

Direct costs for CAP management include medicines, investigations, consultation, and hospitalization duration;

indirect costs include transportation, food, child care, lost time and income of parents/care givers. Nursing cost<sup>6</sup>, laboratory investigations, and oxygen therapy affect costs<sup>7</sup>. Choice of initial antibiotics influences hospitalization duration; inappropriate therapy results in additional costs<sup>8</sup>. Saha *et al* (2017) showed that compared with indirect costs, direct costs were maximal. Among different drugs, antibiotics were financially the most burden some on patients and their families<sup>9</sup>.

We retrospectively assessed clinico-demographics and resource utilization (including direct and indirect costs) in under-5 with newly diagnosed CAP.

### MATERIALS AND METHODS

We retrospectively reviewed medical records of under-5 hospitalized in Dr Balabhai Nanavati Hospital (private hospital, PVH) and Dr RN Cooper Municipal General Hospital (public hospital, PBH), Mumbai, India, between January 2012 and 2014. We conducted the study in compliance to protocol and all relevant regulatory guidelines after obtaining institutional ethics committees' approval.

Children with a new pulmonary infiltrate associated with any of following symptoms—new or increased cough, fever or hypothermia, leukocytosis, left shift, or leukopenia—with complete medical records and confirmed CAP diagnosis (Fig 1) were included. Children with hospital-acquired pneumonia, asthma, chronic obstructive pulmonary disease, bronchiolitis, or common cold were excluded.

Data on demographics, comorbidity, diagnostic tests, medications, hospitalization duration and ICU stay, and

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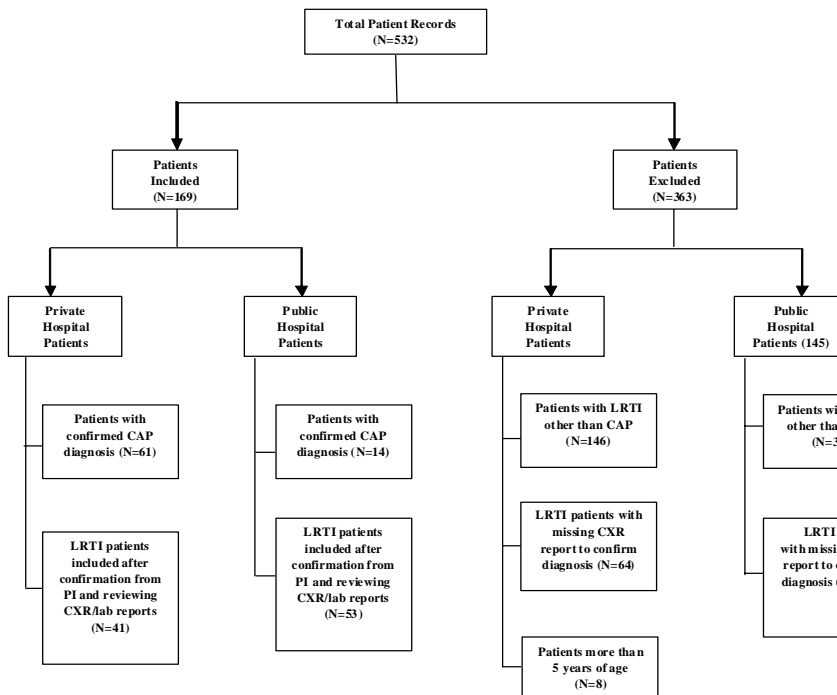


Fig 1 — Flow Diagram for Study Subjects  
CAP=community-acquired pneumonia; CXR=Chest X-ray; LRTI=lower respiratory tract infection; N=number of patients; PI=principal investigator

inpatient costs (from discharge records) were collected.

Outpatient data were collected by a self-administered survey from<sup>5</sup> leading pediatricians. Questionnaire items included resource use for laboratory tests (diagnosis and follow-up), physician visits, and pharmacotherapy. Total outpatient costs were estimated by multiplying average cost for each resource by its frequency. Sick-time costs associated with lost productivity (time off from work by parents/caregivers) were assessed through telephonic interviews regarding type of work, designation, organization, salary range, and paid leaves availed for nursing children.

Statistical analyses were performed using SAS© version 7.0. Continuous variables were summarized using mean, median, and standard deviation. Categorical variables were summarized by frequency. Multivariate log linear regressions were performed to understand if age, gender, and weight predicted total inpatient cost.

### RESULTS

Of 532 children, 169 (31.76%) under 5 with confirmed CAP diagnosis were included: 102 (60.35%) from PVH and 67 (39.64%) from PBH (Fig 1).

Mean±standard deviation (SD) patient age was 1.95±1.45 years in PVH and 1.51±1.17 years in PBH. Most PBH patients were males (59.70%); equal gender distribution was observed in PVH. Mean±SD patient weight was more in PVH (9.95±3.91 *versus* 7.71±2.43kg) (Table 1).

Cough and fever were commonest reasons for hospi-

talization in both settings, followed by breathlessness (52.24%) in PBH. Primary diagnosis was unspecified pneumonia in most children (~93%) in both settings. Vaccination rate was higher in PVH patients (79.41% *versus* 65.67%) (Table 1).

Complete blood count and chest radiograph were primary diagnostics used in >90% under 5 admitted to both facilities. Mycoplasma pneumoniae immunoglobulin M (IgM) test was performed in 32.35% PVH patients compared with none in PBH. Blood culture was performed in 37.25% and 8.95% PVH and PBH patients, respectively. Sputum culture was performed in 13.43% PBH patients (Table 2).

PVH patients received linezolid (66%), azithromycin (25%), and amoxicillin/clavulanate (15%). Most PBH pa-

Table 1 — Baseline Sociodemographic and Clinical Characteristics

Characteristics	Private Hospital (N=102)	Public Hospital (N=67)
Age (years), Mean±SD	1.95±1.45	1.51±1.17
≥1 month (%)	1.96	1.49
1 month–1 year (%)	34.31	43.28
>1 year (%)	63.73	55.22
<b>Weight (kg), Mean±SD</b>	<b>9.95±3.91</b>	<b>7.71±2.43</b>
<b>Gender (%) :</b>		
Female	48.04	40.30
Male	51.96	59.70
<b>Primary Reasons for Hospitalization (%) :</b>		
Breathlessness	16.67	52.24
Chest Pain	0.98	-
Cough	94.12	95.52
Fever	91.18	94.03
Tachypnea	3.92	-
Wheezing	0.98	-
<b>Other Reasons (%) :</b>		
Chills	5.88	-
Cold	56.86	88.06
Rapid Breathing	0.98	-
Vomiting	15.69	-
Murmur	-	1.49
<b>Primary Diagnosis of Pneumonia (%) :</b>		
Mycoplasma	3.92	-
Viral	2.94	-
Bacterial	-	7.46
Other/unspecified	93.13	92.53
<b>Vaccination (%) :</b>		
Done	79.41	65.67
Unknown	16.66	10.44
Not done	3.92	23.88

**Table 2 — Laboratory and Imaging Tests for Diagnosing Community-acquired Pneumonia**

Diagnostic Test	Private Hospital (N=102)	Public Hospital (N=67)
<b>Laboratory Test (%) :</b>		
Complete blood count	91.17	95.52
Blood culture	37.25	8.95
Sputum culture	1.96	13.43
Malaria	30.39	40.29
Mycoplasma pneumoniaeimmunoglobulin M	32.35	-
Dengue	7.84	4.47
Blood gas analysis	0.98	-
<b>Imaging Test (%) :</b>		
X-ray	92.15	95.52
Computed tomography	9.80	-
Other	17.64	-

tients received amoxicillin/clavulanate (91%), followed by amikacin (16%) and ceftriaxone (10%). After discharge, 85% PVH patients continued antibiotics for 4.3 days (mean) compared with 54% PBH patients for 2 days (mean).

Overall mean±SD hospitalization duration was shorter in PVH (5.87±3.50 versus 7.97±4.74 days), also if it was a general ward (4.63±2.18 versus 7.59±4.41 days). This trend was similar in PVH irrespective of routes of antibiotic administration—intravenous (6.91±5.13 versus 7.51±4.63 days), oral (5.22±3.60 versus 12 days), or both (5.41±2.42 versus 9.44±4.83 days). However, mean ICU stay was longer in PVH (0.75±2.67 versus 0.19±1.59 days).

Inpatient costs are provided in Table 3. Mean±SD diagnostics cost was approximately 4 times higher in PVH (4,750±5,513; \$76±8) than in PBH (1,807±1,516; \$29±24). No cost was incurred for hospitalization in general and other wards, physician visits, and consumables in PBH; mean cost for these activities was approximately 19,000 (\$301) in PVH. Mean±SD inpatient cost per CAP episode was much higher for PVH patients (34,535±32,483; \$553±520) than for PBH patients (4,934±7,254; \$79±116).

Mean outpatient cost of treating a CAP episode was 10,688 (\$148). Per caregiver interviews, sick-time cost for 9.5 days (mean) (PVH: mothers 5.5 days; fathers 4 days) of paid leaves was 9,286 (\$129). Parents (mostly mothers) of under-5 in PBH availed an average 6 days of paid leaves amounting to 3,118 (\$43) as sick-time cost.

Exploratory regression analysis demonstrated that age, gender, and weight did not significantly predict inpatient cost in PVH; however, age (p=0.0014) and age and weight together (p=0.001) were associated with inpatient cost in PBH.

**DISCUSSION**

Our results provide insights into the economic bur-

den of CAP management on families of under-5. Mean inpatient cost was 7 times higher in PVH than in PBH and almost 3 times higher than mean outpatient cost. This finding corroborates with the estimates of Indian National Health Accounts reporting a household expenditure of 64,628 crores (\$8976 million) on PVH compared with 8,193 crores (\$1138 million) on government hospitals<sup>10</sup>.

Patients’ demographic and clinical characteristics were similar at both facilities, except for weight. Lower vaccination rate and higher breathlessness case numbers in PBH suggest parents’ unwillingness to seek treatment unless symptoms worsen. Indirectly, this reflects parents’ inability for paying healthcare costs.

Both facilities used radiographic evidence (CXR) for diagnosis per the Indian guidelines<sup>5</sup>. Blood and sputum culture, M pneumoniae IgM test, and bacterial pneumonia identification tests were not performed in PBH. Of 32.35% PVH children tested for M pneumoniae IgM, only 3.92% were positive. Per Indian CAP guidelines, this test need not be routinely performed<sup>5</sup>. An empirical treatment is recommended in children<sup>11</sup> since clinical features or laboratory and radiological investigations cannot reliably differentiate infections caused by atypical pathogens, bacteria, and viruses in children<sup>12</sup>. Identifying causal pathogens influences treatment choice and affects overall healthcare utilization (HRU) costs. We found a considerable expenditure on laboratory tests (4,750; \$66) in PVH, increasing the overall economic burden on the families.

Compared with achieving late response in CAP patients, achieving early response (=4 days) decreases hospitalization duration, lowers ICU admission rate, shortens ICU stay, and causes lesser initial treatment modification or readmission<sup>13</sup>. Key contributors of CAP associated direct medical costs in India identified earlier were hospitalization duration<sup>7</sup> and antibiotic use<sup>9</sup>. Medicine cost

**Table 3 — Inpatient Costs Associated with Community-acquired Pneumonia**

Parameters	Private Hospital (N=102)		Public Hospital (N=67)	
	Cost Per Patient		Cost Per Patient	
<b>Clinical Services, Mean±SD :</b>				
Lab Tests	4750±5513	\$70±77	1807±1516	\$25±21
Non-lab Tests	1356±2224	\$19±31	-	-
Imaging	2497±4530	\$35±63	41±34	\$0.57±0.47
<b>Hospital Services, Mean±SD :</b>				
Admission	187	\$2.6	10	\$0.14
Intensive care unit	2500±8708	\$35±121	39±318	\$0.62±5
General ward	9816±6325	\$136±88	-	-
Other wards	1560±6062	\$22±84	-	-
Physician visit	6464±5776	\$90±80	-	-
Consumables	976±2019	\$14±28	-	-
Medications	3829±5210	\$53±72	3036±5810	\$42±81
<b>Surgical Services, Mean±SD :</b>				
Surgeon’s fee	207±1068	\$3±15	-	-
Consumables	332	\$4.6	-	-
<b>Other Services</b>	61±198	\$0.85±2.75	-	-
<b>Average Cost</b>	34,535±32,483	\$480±451	4934±7254	\$69±101

mostly (72%) contributes to total out-of-pocket payments (from 42% for inpatient care to 82% for outpatient care)<sup>14</sup>. We report similar findings regarding mean hospitalization duration (PVH: 5.87 days; PBH: 7.97 days) and medication costs (PVH: 3,829; \$46 and PBH: 3,036; \$42). Although physician visits, consumables, and general ward expenses are not charged in PBH, patients spend out-of-pocket for medicines and the Government incurs a considerable expenditure. A systematic review found that mean hospitalization duration for children with severe pneumonia was 5.8 (interquartile range [IQR] 5.3–6.4) and 7.7 (IQR 5.5–9.9) days in low- and middle-income countries and high income countries<sup>15</sup>. We found that hospitalization duration in PBH was equivalent (7.97 days) to that in high-income countries.

Cost burden of outpatient CAP management is less explored. We found mean outpatient cost was same for PBH and PVH (10,688; \$148). Loss of work productivity and increased sick-time costs accounted for 20% and 38% of total cost in PVH and PBH, placing a considerable burden on parents/caregivers. Indian families spent ~10% of total household income on treatment of acute morbidities in children<sup>16</sup>. Mean direct nonmedical and indirect costs for severe pneumonia management were 0.5%–31% of weekly household income<sup>15</sup>.

Various international and Indian guidelines recommend pneumococcal vaccination in children. Two pneumococcal conjugate vaccines (PCVs), PCV13 and PCV10, are licensed in India<sup>17</sup>. PCV13 is introduced from 2017 under Universal Immunization Programme of 5 states<sup>18</sup>. PCV13 has an acceptable safety profile in infants and toddlers, and covers most serotypes prevalent in India<sup>19</sup>. Thus, extensive coverage of PCV vaccination would prevent CAP-associated mortality and reduce hospitalization-associated economic burden.

Study limitations include small sample size, limiting generalizability of findings; self administered questionnaires for evaluating outpatient HRU cost, which may not represent actual expenditure; and the recall method for calculating caregiver's sick-time cost. Parents'/caregivers' reduced work performance (after returning to work) during children's recovery period was not assessed.

### Conclusion :

HRU cost for CAP considerably consumes the monthly income of Indian families, irrespective of treatment settings. Definitive diagnosis and appropriate antibiotic cover may reduce hospitalization duration. Pneumococcal vaccination in under-5 may reduce overall economic burden of CAP management.

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