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ORIGINAL ARTICLE

Clinical outcome and direct economic cost of treatment of community-acquired pneumonia in children older than 28 days and younger than five years: A multicenter observational study

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Abstract

Introduction: Community-acquired pneumonia (CAP) is a public health problem mainly affecting children under five. Episodes that require hospitalization generate high institutional financial costs. The objective of this study was to describe the clinical results and the direct cost of CAP treatment in two reference hospitals in Quito-Ecuador.

Methods: This cross-sectional study was conducted in children >28 days and <5 years hospitalized in two public health institutions in Quito, Ecuador, with CAP. Variables were demographic descriptions, clinical outcomes, and cost of treatment. The data are presented with descriptive statistics.

Results: A total of 355 cases were analyzed, including 190 men (53.5%). Younger infants had 95 cases (26.8%), older infants 130 cases (36.6%), and schoolchildren 130 cases (36.6%). The main symptoms were hypoxemia in 353 cases (99.4%), tachypnea in 239 cases (67.3%), tachycardia in 177 cases (49.9%), and mild respiratory difficulties in 268 cases (75.5%). Treatment was mainly with analgesics in 345 cases (97.2%), antibiotics in 335 cases (94.4%), bronchodilator nebulization in 207 cases (58.3), parenteral fluids in 203 cases (57.2%), and oxygen in 107 cases (30.1%). The average cost of hospital care for CAP was 736.18 ± 320.51 USD. There was no cost difference between institutions (P >0.05).

Conclusion: The health cost of medical care in Ecuador is approximately two times the minimum living wage, and treatments are adjusted to current medical practice guidelines.

Keywords: **MESH**: Pneumonia, Child, Costs and Cost Analysis, Hypoxia, Tachypnea.

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Introduction

Diseases that affect the respiratory system are a global health problem, even more so in childhood. As part of these pathologies, it is necessary to define community-acquired pneumonia (CAP) as "infection of the lung parenchyma in children who have not been hospitalized for at least a week before or who develop symptoms after 48 hours of hospital discharge" [1].

In the population around the world corresponding to children under five years of age, CAP is considered a significant cause of morbidity and mortality, contributing to approximately 3 million deaths per year, especially in underdeveloped countries such as Ecuador [2].

Due to its impact on pediatric health, healthcare professionals must be up-to-date with the academic tools offered for the clinical and pharmacological management of CAP [3].

It is crucial to recognize that not all CAP episodes require hospital care or become fatal, and the cases that need care in a health home correspond primarily to children under two years of age [3].

Currently, Ecuador has the Clinical Practice Guide of the Ministry of Public Health of 2017 as a working tool. "Community-acquired pneumonia in patients from 3 months to 15 years of age", whose recommendations are guidelines for managing this disease based on the best scientific evidence, is a document that is addressed to doctors and nurses who are in charge of the direct care of pediatric patients, constituting an application instrument in different health homes under article 146 numeral 2 of the Comprehensive Organic Criminal Code. (Ministry of Public Health, 2017). According to data from the World Health Organization (WHO) and the United Nations Children's Fund (Unicef), 5.3 million lives could be saved in developing countries by 2015 if an average of $39 billion, or $12.9 per child [4].

In Ecuador, there are few scientific research studies with an economic approach that evaluate health spending after CAP treatment in children, and carrying out this study would set a benchmark for future projects in hospital interventions for CAP to reduce preventable deaths in children due to respiratory pathology at the local level [5].

Therefore, the objective of the treatment is to describe the clinical results based on what is presented in the Ministry of Health Guide and the direct cost of CAP treatment between the San Francisco General Hospital and the Enrique Garcés General Hospital in the city of Quito in 2019.

Materials and methods

Design of the investigation

This design is an observational, cross-sectional study, and the source was retrospective.

Scenery

The study was carried out in the pediatric services of the San Francisco de Quito Hospital of the Ecuadorian Social Security Institute and the Enrique Garcés General Hospital of the Quito-Ecuador Ministry of Public Health. The study period was from January 1, 2019, to December 31, 2019.

Inclusion criteria

Children older than 28 days of age and younger than five years with a diagnosis of community-acquired pneumonia entered the study. Patients with associated comorbidities (heart disease, congenital anomalies, renal failure, liver failure, oncological pathologies, and hematological disorders) were excluded. Children referred to the third level, the pediatric intensive care unit, children with immunodeficiency, and severe chronic pathology were also excluded. Cases with incomplete electronic records that did not allow analysis were eliminated from the study.

Study size

The population consisted of patients admitted to the institution who met the admission requirements. The sample calculation was nonprobabilistic, with a census type of all possible cases.

Variables

The variables were age, sex, origin, ethnicity, educational level of the caregiver, type of pneumonia (bacterial, atypical, viral), clinical characteristics (hypoxemia, tachycardia, tachypnea, subcostal retractions, wheezing, respiratory distress determination scale of

Wood-Downes-Ferrés), treatment received, hospital stay and healthcare cost.

Data sources/measurement

The data were collected from the electronic file. The database was coded with serial numbers, thus protecting the confidentiality of the information and identity of the patients. For case investigation, the following ICD-10 codes were used: J129, J158, J159, J180, and J189.

Regarding the direct economic cost, the basic hospital care codes were obtained at the second level of care from the benefit schedule for the national health system version 2014, currently applied under Official Register No. 289 since May 24, 2014. 2012.

The hotel, food, and medical fees codes described in the TPS were multiplied by each patient's hospitalization days. The data corresponding to laboratory and imaging were multiplied by the number of tests performed during hospitalization for each patient, thus obtaining the cost in US dollars.

Regarding medicines and medical supplies, the materials needed by each patient during their hospitalization period were calculated in units and multiplied by the unit cost in US dollars.

Information about the cost of medicines was obtained based on the consolidated ceiling prices for 2019, established by the MSP's Technical Secretariat for Medicine Pricing. At the same time, the cost of medical supplies was obtained from the institutional pharmacy based on purchases for the year of study. The rate code for the provision of services published in the official registry of Ecuador for the year 2014 in force for public management was used.

Avoidance of bias

To guarantee the reliability of the information, the researchers were trained in data collection. A double checklist was used to include all cases. The data were validated and curated by the principal investigators. To avoid possible interviewer, information, and memory biases, the primary investigator kept the data at all times with a guide and appropriate records. Observation and selection bias was avoided by applying the participant selection criteria.

Statistical method

A descriptive analysis was performed with summary and dispersion measures: mean and standard deviation for scale variables and frequency and percentage for categorical variables. Additionally, an inferential analysis is presented, the means are compared with Student's t, and the frequencies are compared with the chi-square test. The statistical package SPSS v.25 (Armonk, NY: IBM Corp.) was used for statistical analysis.

Results

The study included 355 patients.

General characteristics

A total of 355 patients were studied, 190 men (53.5%) and 165 women (46.5%). A total of 247 cases (58.3%) corresponded to the San Francisco de Quito General Hospital and 108 (41.7%) to the Enrique Garcés General Hospital. There were 95 younger infants (26.8%), 130 older infants (36.6%), and 130 schoolchildren (36.6%) (Table 1). The rest of the demographic characteristics are presented in Table 1.

Table 1. Characteristics of the population according to the type of NAC.

Variable	Bacterial N =321 (90.4%)	Atypical N=11 (3.1%)	Viral N =23 (6.5%)	Total No. (%)
Sex				
Woman	151 (47%)	4 (36.4%)	10 (43.5%)	165 (46.4%)
Men	170 (53%)	7 (63.6%)	13 (56.5%)	190 (53.5%)
Groups age				
lact. minor	80 (24.9%)	4 (36.4%)	11 (47.8%)	95 (26.8%)
lact. higher	117 (36.4%)	3 (27.3%)	10 (43.5%)	130 (36.6%)
Preschool	124 (38.6%)	4 (36.4%)	2 (8.7%)	130 (36.6%)
Ethnicity				
Hispanic	308 (96%)	11(100%)	23 (100%)	342 (96.3%)
Others	13 (4%)	0	0	13 (3.7%)
Residence				
Urban	247 (76.9%)	5 (45.5%)	19 (82.6%)	271 (76.3%)
Rural	74 (23.1%)	6 (54.5%)	4 (17.4%)	84 (23.7%)
Level of education of the caretaker				
Primary	52 (16.2%)	1 (9.1%)	1 (4.3%)	54 (15.2%)
Secondary	183 (57%)	5(45.5%)	17 (73.9%)	205(57.7%)
Superior	86 (26.8%)	5(45.5%)	5 (21.7%)	96 (27%)

Lact.: lactating.

Table 2. Clinical characteristics according to the type of CAP.

Variable	Bacterial N =321 (90.4%)	atypical N=11 (3.1%)	Viral N =23 (6.5%)	Total No. (%)
Hypoxemia	321 (100%)	10 (90.9%)	22 (95.7%)	353 (99.4%)
Tachypnea	220 (68.5%)	7 (63.6%)	12 (52.2%)	239 (67.3%)
Tachycardia	163 (50.8%)	5 (45.5%)	9 (39.1%)	177 (49.9%)
SC Retract.	111 (34.6%)	6 (54.5%)	10 (43.5%)	127 (35.8%))
Wheezing	62 (19.3%)	4 (36.4%)	4 (17.4%)	70 (19.7%)
Wood-Downes-Ferrés respiratory distress *				
Mild	240 (74.8%)	8 (72.7%)	20 (87.0%)	268 (75.5%)
Moderate	81 (25.2%)	3 (27.3%)	3 (13.0%)	87 (24.5%)
Treatment received				
Analgesic	317 (98.8%)	10 (90.9%)	18 (78.3%)	345 (97.2%)
Antibiotic	321 (100%)	11 (100%)	3 (13.0%)	335 (94.4%)
NDB	183 (57.0%)	8 (72.7%)	16 (69.6%)	207 (58.3%)
IV fluids	186 (57.9%)	5 (45.5%)	12 (52.2%)	203 (57.2%)
Oxygen	91 (28.3%)	0 (0%)	16 (69.6%)	107 (30.1%)
SA	75 (23.4%)	6 (54.5%)	3 (13.0%)	84 (23.7%)
Corticosteroid	66 (20.6%)	4 (36.4%)	3 (13.0%)	73 (20.6%)
RT	51 (15.9%)	1 (9.1%)	2 (8.7%)	54 (15.2%)
Physical Med.	30 (9.3%)	4 (36.4%)	2 (8.7%)	46 (13.0%)
Antihistam	9 (2.8%)	2 (18.2%)	0 (0%)	11 (3.1%)
NACs	7 (2.2%)	0 (or%)	1 (4.3%)	8 (2.3%9
mucolytic	6 (1.9%)	0 (0%)	1 (4.3%)	7 (2.0%)

SA: Secretions aspiration. NBD: nebulization with a bronchodilator. NACs: Nebulization with Acetyl Cysteine. RT: respiratory therapy. MEd.: Physical media. Retrac.SC: subcostal retraction.

Etiological and clinical classification and treatment of CAP

A total of 90.4% of the cases corresponded to bacterial pneumonia (Table 1). The average number of days of stay was 5.52 ± 2.3 days. The clinical characteristics are presented in Table 2; the main characteristic was hypoxemia followed by tachypnea. (Table 2). Seventy-five percent of the cases presented mild respiratory distress. In most cases (97.2%), they received NSAIDs, antibiotics (94.4%), nebulizations (58.3%), parenteral fluids (57.2%), and oxygen (30.1%) (Table 2). The relationship between the Wood-Downes-Ferrés respiratory distress scale and the length of hospital stay. There were no differences between the severity and length of hospitalization (Table 3).

Healthcare cost of CAP care

The healthcare cost is presented in US dollars in Tables 4 and 5. There was no cost difference between institutions (P >0.05) (Tables 4 and 5). The average cost of hospital care for CAP was 736.18 ± 320.51 USD.

Table 3. Relationship between the Wood-Downes-Ferrés respiratory distress scale and the days of stay.

Scale	Up to 5 days n=210	> 5 days No. =145	Total n=355	*Q**
1	35 (16.7%)	20 (13.8%)	55 (15.5%)	
2	54 (25.7%)	37 (25.5%)	91 (25.6%)	
3	78 (37.1%)	46 (31.7%)	124 (34.9%)	0.4755
4	35 (16.7%)	33 (22.8%)	68 (19.2%)	
5	8 (3.8%)	9 (6.2%)	17 (4.8%)	

*Chi-squared.

Table 4. Hospital health cost of the NAC.

costs (Dollars)	Hospital	Bacterial n=321	Atypical n=11	Viral n=23
Institutional and professional services	HGSF	365.3 ± 143.80	378.3 ± 214.39	385.15 ± 121.67
	HEG	436.98 ±196.59	-	230.98 ± 133.16
laboratory and therapies medical	HGSF	186.52 ± 75.78	218.93 ± 136.08	184.12 ± 46.01
	HEG	213.55 ± 95.70	-	135.43 ± 64.92
Medicines	HGSF	107.68 ± 68.39	68.22 ± 80.34	9.52 ±19.25
	HEG	131.09 ±68.25	-	0.50 ±0.89
Medical supplies	HGSF	49.31 ± 21.27	53.12 ±31.04	51.0 ±17.25
	HEG	52.29 ±26.42	-	29.22 ± 18.7
total cost	HGSF	708.81 ±263.06	718.58 ±455.19	629.80 ±190.02
	HEG	833.93 ±351.59	-	396.15 ± 214.62

*Value in US dollars (USD). HGSF: Hospital of the Ecuadorian Social Security Institute. HEG: hospital of the Ministry of Public Health of Ecuador.

Table 5. Healthcare cost of CAP care by the hospital.

	HGSF **n=247**	**HEG**	***P***
Institutional and professional services	366.36 ± 146.41	404.55 ± 202.09	0.8827
Laboratory and medical therapies	76.33 ± 53.26	78.45 ± 53.53	0.9808
Medicines	103.53 ± 70.08	110.54 ± 78.75	0.9527
Antibiotics	112.22 ± 73.13	121.33 ± 83.81	0.9414
Others	9.05 ± 12.48	4.77 ± 10.91	0.8324
Medical supplies	49.5 ± 21.61	48.66 ± 26.66	0.9820
Total cost	707.33 ± 271.53	765.02 ± 369.49	0.9040

**Value in US dollars (USD). HGSF: Hospital of the Ecuadorian Social Security Institute. HEG: hospital of the Ministry of Public Health of Ecuador HGSF: Hospital of the Ecuadorian Institute of Social Security. HEG: hospital of the Ministry of Public Health of Ecuador.

Discussion

CAP is a pathology that generates many hospitalization cases and costs in the health system.

The most common age group was older infants and preschoolers, at 36.6%; in this result, there are differences with what was indicated in a regional study [6], which describes that most patients with CAP hospitalized are under two years of age.

The most frequent caregiver's education level was secondary (57.7%); this aspect is taken into account by Andrés Martín et al. (2012) [7] as a host-dependent risk factor for CAP, especially if the level of education is low.

The highest prevalence of community-acquired pneumonia was that of bacterial origin, with 90.4%; this result is not related to the data reported by Nascimento-Carvalho (2020) [8] about the fact that viral agents are more frequent in hospitalized patients.

The most frequent characteristics that occurred included hypoxemia in 99.4%, tachypnea in 67.3%, tachycardia in 49.9%, subcostal retractions in 35.8%, and wheezing in a total of 19.7%. The respiratory score at the most frequent hospital admission was mild in 34.9% of patients. All these elements have been widely noted as part of CAP symptoms [8], emphasizing tachypnea and hypoxia as the main symptoms.

The treatment administered to the HEG patients consisted mainly of antibiotics in all patients with CAP of bacterial origin and none of the cases of viral CAP. In contrast, in the HGSF, antibiotics were administered in 98.8% of the cases. In all cases, in all patients with CAP of bacterial and atypical origin and 50% of viral ones, in this regard, it should be noted, according to some authors [8-10], that there are a series of guidelines to establish the most effective drug according to the bacterial agent involved, regarding the treatment of CAP of bacterial origin and the recommendation to treat them with antibiotics.

Other medications frequently used in the HEG were analgesics in 77.7% of patients with bacterial CAP and 70.6% of patients with viral CAP; these were used more frequently in the HGSF, with 98.3% in CAP of bacterial origin, 90.9% in atypical CAP and 100% in viral CAP. IV fluids were used in 78% of the patients who presented with CAP of bacterial origin and 58.8% with CAP of viral origin in the HEG, while in the HGSF, in 50% of those who presented with CAP of bacterial origin, 45.4% had atypical CAP and 33.3% had viral CAP. Oxygen use was recorded in 100% of the patients when it was bacterial CAP and 94.1% when it was of viral origin in the HEG, while in the HGSF, it was administered to all patients regardless of the origin of the CAP.

In the HEG, mucolytics were administered in 6.5% of patients more frequently among those with bacterial CAP (6.6%) and viral CAP (5.9%), and antihistamines were administered in 1.9%, all of bacterial origin; in the HGSF, they were not administered. Mucolytics were administered, antihistamines were administered in 3.6%, and 18.2% were of atypical origin. Regarding mucolytics, they do not have scientific support for their use in CAP, and antihistamines are not recommended in children under three years of age [11].

Corticosteroids were used in 14.8% of the patients, more frequently when the origin was bacterial in 16.5% of the patients seen in the HEG. In comparison, in the HGSF, they were used in 23.1% of the patients, more frequently when the origin was atypical in 36.4% and viral in 33.3%. This drug should be indicated only in cases of severe disease or complications such as pleural effusion, and it is necessary to continue evaluating

its efficacy as adjuvant therapy. It is important to emphasize that according to the admission score, the patients in this investigation were not in severe condition.

In both hospitals, the patients remained hospitalized between 1 and 18 days, with a mean of 5.32 (SD ± 2.05) days in the HGSF and 5.69 (SD ± 2.87) days in the HEG. These results are within the set parameters [8-10].

In both hospitals on discharge, all patients scored 0, an aspect indicated by other studies as discharge criteria: good patient evolution with no signs of distress and clinical improvement [9].

The highest health cost occurred in the group providing institutional and professional services during hospitalization, according to the TPS, being higher in the HEG, which registered an average of $404.55, with a predominance of bacterial CAP that reached an average of 436.98 $. This average cost in the HGSF was 366.36 $ in total for this service and with more in cases of atypical CAP with 378.3 USD $ on average, but with a higher standard deviation.

In the rest of the costs, both hospitals registered similar means, where the second place was the cost of medicines, $110.54 for the HEG and $103.53 for the HGSF; in the two hospital units, there is a predominance of antibiotic costs compared to other drugs. After this, the cost of laboratory and medical therapies is evident, with $78.45 for the HEG and $76.33 for the HGSF. Finally, the lowest cost is represented by medical supplies, $48.66 for the HEG and $49.52. $ for the HGSF. Overall, healthcare costs were higher in the HEG group than in the HGSF group.

The limitations of the study are the viability of the sources; when reviewing the literature in Ecuador, the Clinical Practice Guideline of the Ministry of Public Health to be applied has yet to be updated since 2017. Regarding time, after the coronavirus pandemic decree in March 2020, the search time was reduced; additionally, the source was retrospective. New prospective studies should take these limitations into account.

Conclusions

The health cost of medical care in Ecuador is approximately two times the minimum living wage. The treatments adjusted to the current medical practice guidelines correspond to analgesics (97.2%), antibiotics (94.4%), nebulizations (58.3%), parenteral fluids (57.2%), and oxygen (30.1%).

Abbreviations

CAP: community-acquired pneumonia.
HEG: Enrique Garcés Hospital (MSP).
HGSF: San Francisco de Quito General Hospital (IESS).

Supplementary information

No supplementary materials are declared.

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Author contributions

Daysi Mireya Llerena Montenegro: Conceptualization, Data retention, Fundraising, Research, Resources, Software, Writing - original draft.
Verónica Sofía Miranda Benalcázar: Conceptualization, Data preservation, Supervision, Fundraising, Research, Resources, Writing: review and editing.
Jorge Chalco Navas: Conceptualization, Data conservation, Supervision, Acquisition of funds, Research, Resources.
Carlos Erazo Cheza: Conceptualization, Data conservation, Supervision, Acquisition of funds, Research, Resources.
All authors read and approved the final version of the manuscript.

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Availability of data and materials

The data sets generated and analyzed during the current study are not publicly available due to participant confidentiality but are available through the corresponding author upon reasonable scholarly request.

Statements

Ethics committee approval and consent to participate

It was not required for an observational study.

Publication Consent

This does not apply to studies that do not publish MRI/CT/Rx images or physical examination photographs.

Conflicts of interest

The authors declare they have no conflicts of interest.

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