

Tendency analysis of admission rates for bacterial pneumonia in children and adolescents

Análise da tendência das taxas de internações por pneumonia bacteriana em crianças e adolescentes

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Abstract

Objective: To analyze distribution and tendency of hospital admissions rates for bacterial pneumonia in children and adolescents.

Methods: This ecological, time series study included secondary data obtained from the Hospital Information System of the SUS. We calculated hospital admission coefficients for 10,000 inhabitants triennially. For the analysis of tendency, a model of polynomial regression was used.

Results: Most hospital admissions occurred in the East health macro-region between the second and fourth triennial periods. Rates were higher for children age one to four years and in male patients throughout the study period. We observed an increased tendency toward hospital admission in children younger than one year.

Conclusion: Hospital admission rates for pneumonia differ by health macro-region, age and sex. The region with the highest incidence was the East region, and boys aged one to four years were more affected. A growing tendency was seen in children younger than one year.

Resumo

Objetivo: Analisar a distribuição e a tendência das taxas de internações por pneumonia bacteriana em crianças e adolescentes.

Métodos: Estudo ecológico de séries temporais com dados secundários obtidos no Sistema de Informações Hospitalares do Sistema Único de Saúde. Foram calculados coeficientes de internação para 10.000 habitantes, por triênio. Para análise de tendência utilizaram-se modelos de regressão polinomial.

Resultados: As maiores taxas de internação ocorreram na Macrorregião de Saúde Oeste, entre o segundo e o quarto triênio. As taxas foram maiores na faixa etária de um a quatro anos e no sexo masculino, durante todo o período. Observou-se tendência crescente das internações em crianças menores de um ano.

Conclusão: As taxas de internação por pneumonia diferem por macrorregional de saúde, idade e sexo, sendo maior na região oeste, em crianças do sexo masculino e com idade entre um e quatro anos, com tendência crescente entre os menores de um ano.

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Introduction

Pneumonia is an important topic because it constitutes the main cause of death among children worldwide. Approximately 90% of deaths from pneumonia occur in developing countries, and half of these deaths occur in Africa.⁽¹⁾ In developed countries mortality rates from pneumonia are low, but the morbidity related to pneumonia remains high.⁽¹⁾

For this reason, different interventions have been implemented to reduce the incidence of bacterial pneumonia, particularly among children up to five years of age. Healthy feeding, maintenance of an unpolluted environment and adequate immunization are factors that can protect children against bacterial pneumonia.^(2,3)

Bacterial pneumonia is considered a condition handled under primary health care (PHC) services; therefore, effective actions at this level of care - prevention, early diagnosis and follow-up of population health conditions - should help avoid hospitalization, especially among children.⁽⁴⁾ PHC is applied in Brazil throughout the Family Health Strategy (FHS) Program, is based mainly on universal and continuous access in a system characterized by a close relationship between the health team and a specific population, and provides value in both the care provided by the health professionals and systematic follow-up. Thus, increasing FHS coverage to a broader population should decrease morbidity and mortality for such primary care conditions as bacterial pneumonia.

Brazil lacks consistent epidemiological data on respiratory morbidity of children and adolescents. This leads to difficulties in planning and executing effective actions for prevention and health promotion. Age is a risk factor inversely proportional to development of respiratory disease; i.e., younger people have a higher risk for respiratory problems, and a higher incidence is seen between ages six and 24 months.⁽⁵⁾

Studies on admission rates, in addition to describing the disease profile, support planning of health services and help sensitize health professionals. On the basis of these assumptions, the objective

of this study was to analyze distribution and tendency of admission rates for bacterial pneumonia in children and adolescents.

Methods

This ecological, descriptive and time series study, conducted from 2000 to 2001, addressed hospital admission due to bacterial pneumonia in children and adolescents from the Paraná State.

Paraná is in the southern region of Brazil and has 399 municipalities divided into six administrative groups called health macro-regions (MRS, acronym in Portuguese). These regions have the responsibility to develop, incentive and support municipality strategies, as well as plan actions to improve quality of population health. The population of Paraná is estimated at 10,444,526 inhabitants. Of these, 14.2% are children (0 to 9 years old) and 17.6% are adolescents (10 to 19 years old) according to census and population estimations.

Data were collected from the Hospital Information System (SIH, acronym in Portuguese) of the SUS Department of Informatics (Datusus), which provides information on admissions to public hospitals and health services affiliated with SUS. We included cases in which bacterial pneumonia appeared as the main cause of admission and were considered type 1 authorizations for hospital admission (ie, initial hospitalization).

We collected data on admissions, census and population estimations related to age range, sex, municipality of occurrence and year of hospitalization for bacterial pneumonia, based on International Classification of Diseases - 10 edition (ICD-10), using the codes J13-J14, J15.3-J15.4, J15.8-J15.9, and J18.1. Hospital admissions, according to municipalities, were grouped according to division in MRS (East, Campos Gerais, West, South Central, Northeast and North).

Age ranges were categorized according to Datusus as younger than one year, one to four years, five to nine years, ten to 14 years, and 15 to 19 years. Years of occurrence of hospitalizations were grouped in four triennials (2000 to 2002, 2003 to 2005,

2006 to 2008 and 2009 to 2011). Data on admission for bacterial pneumonia were presented as absolute frequency of admission measured by 10,000 inhabitants for each age, sex and MRS group.

To estimate tendency, we used analysis via models of polynomial regression given the large statistical power and ease of elaboration and interpretation with this model. Hospital admission rates were considered as a dependant variable (Y) and time (in years) was considered an independent variable (X). To reduce collinearity between terms of equation of regression, we transformed the variable “year” in “year – centralized” (year less than the midpoint of the study year); therefore, 2005 was considered the midpoint of the historical year (year-2005).

In the beginning, we created dispersive flowcharts of admission rates based on years, which led to our choosing a function with a high explanation power. As a reference for choosing a model, we also used statistical significance associated with regression coefficients, including stationary tendency ($p > 0.05$), descending ($p < 0.05$ and negative regression coefficient) or ascending ($p < 0.05$ and positive regression coefficient); and coefficient of determination (r^2) as the measure of the precision model (r^2 closer to 1, with additional adjustment).

The first model tested was simple linear regression ($Y = \beta_0 + \beta_1 x$), in which Y = hospital admission rate, β_0 = mean rate of the period, β_1 = increment of annual mean and x = year-2005. When necessary, we tested models of second degree ($Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2$). When two models were similar, the simplest model was chosen (or of least degree) for a specific observation. We used Microsoft Excel to calculate

hospital admission rates and used SPSS software, version 18.0, to analyze tendencies.

Development of this study followed national and international ethical standards for research on human subjects.

Results

Between 200 and 2011, 2,295.780 hospital admissions among children and adolescents occurred; of these 59,028 (2.57%) were for bacterial pneumonia.

Table 1 shows that East MRS had a higher hospitalization rate, with the exception of the first triennial, as well as a gradual increase in rates throughout the period. The Campos Gerais MRS had the lowest rates in the first triennial but also showed a gradual increase of hospital admission rates.

Table 2 shows that during the 12 years of follow-up, the hospital admission rate was higher among children one to four years of age and among male children.

In the analysis of tendency, we found that, in general, hospital admission rates remained stable throughout the period and that mean coefficients were substantially higher among children age one to four years ($B_0 = 42.223$). However, the only age range that presented a growing tendency of admissions was the group younger than one year ($p < 0.002$); according to the linear model adopted, the precision was 73% ($r^2 = 0.73$). For both sexes, we verified stability in the behavior of hospital admissions throughout the series (Table 3).

Table 1. Hospital admissions and hospitalization rates for bacterial pneumonia in four triennial periods

Macro-region of health	2000-2002 (n=11519)		2003-2005 (n=19718)		2006-2008 (n=15815)		2009-2011 (n=11976)	
	Hospital admission	Admission rate	Hospital admission	Admission rate	Hospital admission	Admission rate	Hospital admission	Admission rate
East	2703	2.22	3475	2.60	2254	1.85	719	0.65
General field	557	1.35	771	1.79	765	1.93	979	2.59
Central-South	1475	5.09	2135	7.19	1464	5.49	1477	5.96
West	2489	4.09	5483	8.73	5030	8.94	5473	10.55
Northeast	1624	2.72	2612	4.33	2622	4.97	1819	3.50
North	2671	4.04	5242	7.79	3680	6.24	1509	2.67

Source: SIH-SUS/Datasus (Ministry of Health)

Table 2. Hospital admissions and hospitalization rates for bacterial pneumonia according to characteristics of children and adolescents

Characteristics	2000-2002 (n=11519)		2003-2005 (n=19718)		2006-2008 (n=15815)		2009-2011 (n=11976)	
	Hospital admission	Admission rate	Hospital admission	Admission rate	Hospital admission	Admission rate	Hospital admission	Admission rate
Age								
Less than 1 year	42	0.24	84	0.45	84	0,58	77	0.53
1 to 4 years	6223	8.50	11188	14.55	9148	14,34	6389	11.15
5 to 9 years	2927	3.09	5223	5.26	4045	4,49	3073	3.97
10 to 14 years	1384	1.44	2283	2.28	1728	1,88	1499	1.64
15 to 19 years	943	0.97	940	0.92	810	0,86	938	1.00
Sex								
Male	6275	3.26	10758	5.33	8624	4,77	6545	3.85
Female	5244	2.82	8960	4.59	7191	4,14	54,31	330

Source: SIH-SUS/Datasus (Ministry of Health); Int – Hospital Admission; TX – Admission Rate.

For all children and adolescents, hospital admission rates in general ranged from 7.75 to 16.46 per 10,000 inhabitants; however, we did not identify this tendency in admissions ($p = 0.46$; $r^2 = 0.0006$), as observed in Table 3. When age ranges were stratified, except for the group less than one year, even with oscillations, we found a significant increase in admission; the remaining ranges continued to be stable in relation to hospitalization for bacterial pneumonia ($p > 0.05$). Despite the tendency toward being stationary, admission rates for bacterial pneumonia among children aged one to four years remained the highest during the period, and reached 59.74 per 10,000 inhabitants in 2003.

Table 3. Tendency of admission rates of children and adolescents by bacterial pneumonia, according to age range and sex

Variables	Model*	r ² **	p-value	Tendency
Age range				
< 1 year	$y=1,532+0.104x$	0.73	0.002	Growing
1-4 years	$y=42,223-0.179x$	0.007	0.82	Stable
5-9 years	$y=14,730-0.194x$	0.056	0.51	Stable
10-14 years	$y=6,465-0.112x$	0.11	0.34	Stable
15-19 years	$y=3,139+0.11x$	0.016	0.72	Stable
< 19 years	$y=14,180-0.183x$	0.006	0.49	Stable
Sex				
Male	$y=15,221-0.203x$	0.060	0.49	Stable
Female	$y=13,153-0.192x$	0.070	0.46	Stable

*Model: y =hospital admission rate; x = year – 2005; **r² = coefficient of determination

Discussion

This study enabled us to understand the distribution and tendencies of hospital admissions for bacterial pneumonia in children and adolescents in the Paraná State. The descriptive analysis of data in

this study precludes the ability to establish causality. In addition, the use of secondary data of SIH/SUS is subjected to errors in recording and processing of information, which represents a risk for incongruity between the system and the reality; in addition the study did not consider the use of affiliated or private health care network and cases of readmissions.

Information systems have been used as a data source for ecological studies. Such use helps enhance the quality of health systems, the applicability of data generated by them, health surveillance actions, and, above all, as proposed in our study, the analysis of avoidable illness caused by care delivery at the PHC level. Therefore, such studies can also help improve nursing actions toward groups in which hospital admission rates for bacterial pneumonia are high or showed a growing tendency.

Despite the availability of a vaccine, the morbidity and mortality for bacterial pneumonia remain a health concern worldwide because the number of children affected by this disease remains high. In 2010, 120 million episodes of pneumonia by *Streptococcus pneumoniae* was recorded, and 14 million cases were severe cases (mainly in children younger than five years of age).⁽⁶⁾ In Brazil, a continental country with wide cultural, social, economic and environmental diversity, pneumonia is always one of the main causes of hospitalizations.⁽⁷⁾ For this reason, it is important to consider environmental and climate influences in the hospital morbidity profile of this problem.⁽⁶⁾ A study conducted in the

United States observed higher rates of outpatient services (between 32.3 and 46.9 per 1,000) for bacterial pneumonia among children younger than five years.⁽⁸⁾ A study of refugee children in 16 African and Asian countries reported that bacterial pneumonia was responsible for 17% of hospital morbidity among children younger than five years, and also demonstrated expressive incidence rates of this disease in Africa (59.2 per 1,000) and Asia (254.5 per 1,000).⁽⁹⁾

Although our study did not investigate the relation of hospital admissions with climate of each macro-region, an interesting finding is that the East MRS, which typically has a cold climate, had a higher absolute frequency of admission for bacterial pneumonia in the second and fourth triennial periods. The same MRS also had higher hospital admission rates, with an increase of roughly 158%, between the beginning and end of the period. However, the North MRS, despite its hot climate, presented a higher admission rate in the second and third triennial periods.

These findings suggest that not only climate can influence the increase of hospital admission for bacterial pneumonia; other factors, among them, the quality of health care delivered and the region of the state, can determine the differences in hospital admissions of children and adolescents throughout the time periods studied. A study carried out in the United Kingdom showed great spatial variation in hospitalization rates for pneumonia among individuals up to 14 years of age.⁽¹⁰⁾

Although the coverage of FHS has increased in Paraná (from 23% in 2000 to 60.2% in 2011), care quality is not uniform; in addition, the relation to causes considered sensible to primary care, such as bacterial pneumonias, is questioned if that level of care is less organized to respond to these diagnoses.⁽¹¹⁾

In relation to age range, the results corroborate a study of main causes of admissions by respiratory disease in children and adolescents in São Paulo. That study found that the frequency of hospital admission for pneumonia was higher in children younger than five years.⁽⁵⁾ A study in Denmark observed that tendency of hospital admission due to

pneumonia in children younger than age five years decreased until 2009, but began increasing from the same year even with an increase in population vaccination.⁽¹²⁾

Results of a study carried out in the United States showed a substantial improvement in vaccination coverage against pneumonia, started in 2000, led to a decrease in hospital admission for pneumonia in children through 2004; this decrease was sustained until 2009.⁽¹³⁾ This result can be attributed to improved access to health service, adoption of prevention measures (mainly the incorporation of pneumococcal vaccine), and the provision of adequate and opportune treatment.

In relation to gender, it is important to highlight the possible biological vulnerability of males for several causes of pneumonia during the fetal and neonatal periods, as pointed out in a retrospective study from Australia that investigated hospital admissions among male children in intensive neonatal care units.⁽¹⁴⁾ This vulnerability can result in neurological complications, increase hospital mortality, trigger functional incapacity and affect the development of males throughout life (if the individual survives), presenting a predisposition for the development of certain pathological conditions.⁽¹⁴⁾

The literature shows that bacterial pneumonia can be prevented through other factors we did not study, including breastfeeding. A cohort study performed in a municipality of the South region of Brazil showed that longer duration of breastfeeding was associated with an overall reduction in hospital admissions for pneumonia among children breastfed exclusively for more than three months. The same study reported that effects of accommodation on decrease of hospital admissions by pneumonia, depend directly of maintenance of breastfeeding.⁽¹⁵⁾

This finding indicates a strategy that health professionals can use to reduce hospital admissions for this population and for this problem. Therefore, the nurse, as a member of the health team must encourage mother-child bonding by accommodation and stress the importance of continuing breastfeeding for up to first two years of life.

Hospital admission rates for bacterial pneumonia in the age ranges studied, except among children younger than one year of age, remained stable during all periods. This finding is a concern because bacterial pneumonia is a disease easily treated with antibiotics when diagnosed in the appropriate timeframe. Although FHS coverage had increased in the last years of the study, the high rates of admissions for this cause or even the stability of this rate can indicate difficulty in access to or lower quality of PHC.⁽⁴⁾

A study of hospital admission rates for bacterial pneumonia between 1998 and 2007 in Australia showed that implementation of pneumococcal vaccination use by national financing and increase of access to vaccination contributed significantly to reduced admission for pneumonia in children aged zero to four years.⁽¹⁶⁾ This study showed given suggestion on what should be done to promote actions to prevent hospital admissions for bacterial pneumonia among children.

For this reason, results of our study show the need to activate mechanisms to improve the epidemiological profile of admissions due to bacterial pneumonia because prevention, diagnosis, treatment of acute disease and follow-up of chronic disease can all help reduce hospital admission for PHC conditions.⁽⁴⁾

In this sense, in 2010 the National Immunization Program included in the vaccination schedule 10-valent pneumococcal conjugate vaccine, which represented an important advance in Brazilian public health concerning prevention of invasive disease and other disease caused by *S. pneumoniae*.⁽¹⁷⁾ However, it is worth to emphasizing that our study delineated tendencies of hospital morbidity related to bacterial pneumonia in 2000 to 2011, which did not permit to assess the effects of vaccination, from the two first months of life, throughout time series studies.

In the future, local studies will be needed to explore nuances of this phenomenon and its temporal progress, with the purpose of obtaining detailed evidences on the behavior of bacterial pneumonia in children and adolescents. In this sense, managers and health professionals can, together, define strategies to strengthen actions of primary care.

Conclusion

Hospital admission for bacterial pneumonia in children and adolescents differed by health macro-region, age and sex. This rate was high in the East region and in male children aged one to four years old. Hospital admission for bacterial pneumonia tends to increase among children younger than one year of age.

Collaborations

Hatisuka MFB; Arruda GO; Fernandes CAM and Marcon SS contributed to the conception of the project, analysis and interpretation of data, critical review relevant for intellectual content and approval of final version of the manuscript to be published.

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