The Impact of the Novel Coronavirus on Brazilian PICUs

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Objectives: To study the impact of the coronavirus disease 2019 pandemic, considering the physical distancing and schools closing, on the characteristics of admission and epidemiology on Brazilian PICUs.

Design: Observational, multicenter, time series analysis, of electronic medical records from 15 PICU in Brazil. Data consisted of all March, April, and May PICU admissions from 2017 to 2020.

Setting: Fifteen private PICUs in Brazil.

Patients: Pediatric patients admitted to the PICU from March to May since 2017.

Interventions: None.

Measurements and Main Results: The period from March 11, 2020, to March 17, 2020, was considered the “intervention point” studied, corresponding to the suspension of school activities and the beginning of physical distancing in Brazil. During the pandemic period studied, there were 28 cases of coronavirus disease 2019 (one death). The mean age was higher ($p = 0.000$), the length of stay was shorter ($p = 0.000$), but mortality rates were similar among the periods ($p = 0.36$). The model estimated a reduction of 1,483 PICU admissions from March 2020 to May 2020. At the end of May, there was an estimated drop of −146.6 bronchiolitis admissions (95% CI, −242.8 to −50.3; $p = 0.016$); −71 asthma admissions (95% CI, −93.6 to −48.63; $p = 0.000$); and −59 community-acquired pneumonia admissions (95% CI, −74.7 to −43.3; $p = 0.000$) per period. The model showed no effect of the “intervention” (physical distancing) on hospitalization rates for epilepsy, diarrhea, sepsis, bacterial meningitis, or surgery when analyzed individually. When assessed together, the model estimated a reduction of 73.6 admissions (95% IC, −132 to −15.2; $p = 0.43$).

Conclusions: The coronavirus disease 2019 pandemic strongly affected Brazilian PICUs, reducing admissions, length of stay, and the epidemiological profile. The measures to oppose the coronavirus disease 2019 pandemic may have prevented thousands of PICU hospitalizations across the country. (*Pediatr Crit Care Med* 2020; XX:00–00)

Key Words: coronavirus infections; critical care; epidemiology; length of stay; patient admission; pediatrics

The spread of the novel coronavirus disease 2019 (COVID-19) urged a never-seen coordinated global response to prepare the health system, including primary care, hospital facilities, and ICUs (1–3). To decrease the resources needed during the peak of COVID-19, many countries have adopted physical distancing to attempt to flatten the COVID-19 curve (4), since most countries were not prepared for the medical need determined by major epidemics, as required by the COVID-19 pandemic (5). In this pandemic, the adult intensive care settings became overcrowded, stressing the health system and the staff. However, data regarding PICUs are still limited.

We hypothesized that, since COVID-19 seems to be milder in children, nonemergency procedures were postponed, physical distancing, and the closing of schools reduced the likelihood of diseases in the pediatric population, the PICUs were impacted by a reduction in the number of hospitalizations. We sought to study the impact of the COVID-19 pandemic, considering the physical isolation and schools closing, on the characteristics of admission to Brazilian PICUs.

MATERIALS AND METHODS

This is a time series study, which collected data regarding PICU admissions from 15 private hospitals (D’Or Network of Hospitals), in four Brazilian states (São Paulo, six hospitals; Rio de Janeiro, seven hospitals; Pernambuco and

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Distrito Federal, one hospital each). Data were extracted from an electronic hospital database (Epimed Monitor UTI; Epimed Solutions, Rio de Janeiro, Brazil). Variables related to the number of hospitalizations and the epidemiological profile of hospitalized patients were analyzed considering the months of March, April, and May of the years 2017, 2018, 2019, and 2020. The study was approved by the Institutional Review Board.

For the statistical analysis, we used the interrupted time series method, through the construction of ARIMA models (autoregressive integrated moving average), taking into account the existing trends and autocorrelations to estimate the effect of the intervention (6). Autocorrelations of the residuals were evaluated with the Ljung-Box Q test. For the construction of the time series, the months from March to May of the years 2017 to 2020 were divided into fortnightly periods, resulting in 24 data points. In the Brazilian states studied, the decrees regulating physical distancing, quarantine, and the suspension of school activities were published in the period from March 11, 2020, to March 17, 2020; therefore, this period was considered as the point of intervention, corresponding to the end of the first half of March.

For the comparison of means between the groups of the different years, we used analysis of variance, with a post hoc analysis with Tukey/Bonferroni tests, when indicated. Data were analyzed with SPSS 20.0 software (IBM Corp., Armonk, NY).

RESULTS

In the year 2020, the mean age of the children hospitalized in PICU was higher, and the PICU length of stay was lower, but the mortality rates were similar among the periods. From March 31, 2020, to May 31, 2020, there were 28 confirmed cases of COVID-19 in the 15 hospitals, with one death (an infant with the previous diagnosis of gastroschisis). The results are summarized in **Table 1**.

The effect of the intervention (physical distancing) on the total number of PICU admissions is depicted in **Figure 1*A***. The coefficient for the pre-intervention slope of the regression line in the ARIMA model showed that, before the intervention, there was a trend for increasing 3.2 admissions per period ($p = 0.04$). The coefficient for the difference between the pre- and the post-slope was negative (–29.9; $p = 0.026$). At the end of May 2020, the model estimated a reduction of 356.7 admissions for every 15 days, resulting in a reduction of 1,483 PICU admissions since the second half of March.

The effect of the intervention on the admissions due to bronchiolitis could be demonstrated in April, with a drop of –104.2 admissions estimated for the second half ($p = 0.025$). At the end of May, there were an estimated –146.6 admissions for the period (May 16–31, 2020; $p = 0.016$). These results are in Table 1 and **Figure 1*B***.

For the diagnoses of asthma, the number of PICU admissions is depicted in **Figure 1*D***. The coefficient for the pre-intervention slope of the regression line in the model showed that, before the intervention, there was a trend for increasing 1.2 admissions per period ($p = 0.038$). At the beginning of March, there was a reduction in asthma admissions (–39; $p = 0.003$) for the period. At the end of May 2020, the model estimated a reduction of 71 admissions for every 15 days.

The effect of the intervention could be seen in the reduction of hospitalization rates for community-acquired pneumonia in the first half of March 2020 (–44.3; $p = 0.000$), leading to a reduction of 59 cases per period in the second half of May, as shown in **Figure 1*C***.

The model showed no effect of the intervention on hospitalizations for epilepsy, diarrhea, sepsis, bacterial meningitis, and surgery. However, excluding the three major causes of hospitalization from the analysis (bronchiolitis, pneumonia, and asthma), and encompassing all the other causes of hospitalization into a single variable, this variable shows a reduction in the number of admissions in the second half of April (–51.1; 95% IC, –92.4 to –10; $p = 0.046$). At the end of May 2020, the model estimated a reduction of 73.6 admissions (95% IC, –132 to –15.2; $p = 0.43$).

For the number of deceased patients, no effect of the intervention could be demonstrated. The model pointed to a reduction of –1.17 deaths in PICUs per period in May 2020, but without statistical significance ($p = 0.36$).

DISCUSSION

In this study, we showed a great reduction in the number of children hospitalized in 15 Brazilian PICUs, as a direct result of physical distancing and the closure of schools. "Staying at home" was never a very effective measure in Brazil, with rates of success around 55%, but schools and daycare centers were 100% closed, and we believe that this closure was the most important factor in reducing hospitalizations. The PICU length of stay was also reduced by more than 20%, and the average age was at least a year and a half higher.

In the months from March to June, every year, a rise in respiratory diseases cause chaos in Brazilian hospitals, with crowded PICUs, with frequent need for new PICU temporary beds in previous years. The burden is high: in Brazil, during 2017, the most frequent causes of hospital admissions in the public health system of children under 5 years old were respiratory diseases (351,763, with 2,349 deaths—0.67%) (7). The peak of respiratory syncytial virus (RSV) infection, the most frequent cause of bronchiolitis, is in April and May, causing more hospitalizations and deaths in equatorial Brazil than influenza (including the 2009 pandemic) (8, 9). About 45% of hospital admissions and in-hospital deaths due to RSV occur in children younger than 6 months (10). Despite the extensive pneumococcal vaccination coverage, bacterial pneumonia is still an important cause of morbimortality in Brazil, particularly in children under 2 years old (11), and most of the deaths caused by asthma (68.1%) occur in children under 5 years. Therefore, our data show that the measures to oppose the COVID-19 pandemic may have prevented thousands of PICU hospitalizations of small children across the country.

TABLE 1. General Data of Patients Admitted Do the PICU From March to May by Year

Variable	2017	2018	2019	2020	*p*
Number of PICU admissions	2,310	2,599	2,564	1,181	–
Age, yr, mean (SD)	2.8 ± 3.8	2.6 ± 6.7	2.5 ± 3.7	4.3 ± 6.9	0.000[a]
Female, *n* (%)	1,056 (45.7)	1,179 (58.4)	1,137 (44.3)	540 (45.7)	–
Pediatric Risk of Mortality death probability (%), mean (SD)	1.5 ± 4.1	1.3 ± 3.5	1.2 ± 2.7	1.2 ± 2.4	–
PICU length of stay, d, mean (SD)	5.2 ± 8.3	5.6 ± 13.9	4.9 ± 6.4	3.8 ± 5.4	0.000[b]
PICU deaths, *n* (%)	24 (1.03)	17 (0.65)	19 (0.74)	9 (0.76)	–
Community-acquired pneumonia, *n* (%)	367 (15.9)	391 (15)	364 (30.8)	86 (7.3)	–
Bronchiolitis, *n* (%)	729 (31.6)	842 (32.4)	834 (32.5)	147 (12.4)	–
Asthma, *n* (%)	242 (10.5)	321 (12.4)	306 (11.9)	101 (8.6)	–
Other conditions, *n* (%)	972 (42)	1,045 (40)	1,060 (41.3)	847 (71.7)	–

Variable	Coefficient Estimate	SE	95% CI for Coefficients	*p*
Effect of intervention on March 16–31, 2020				
Total	−236.7	34.8	−296.9 to −176.5	0.000
Bronchiolitis	−61.9	48.8	−146.3 to 22.5	0.220
Asthma	−39	11.3	−58.5 to −19.4	0.003
Pneumonia	−44.3	9.0	−59.9 to −28.7	0.000
Effect on April 1–15, 2020				
Total	−266.7	27.8	−314.8 to −218.6	0.000
Bronchiolitis	−83.1	43.4	−158 to −8.1	0.071
Asthma	−47	9.5	−63.5 to −30.5	0.000
Pneumonia	−48.0	7.2	−60.4 to −35.5	0.000
Effect on April 16–30, 2020				
Total	−296.7	25.4	−340.7 to −252.8	0.000
Bronchiolitis	−104.2	42.8	−178.3 to −30.2	0.025
Asthma	−55	9.2	−71 to −39.1	0.000
Pneumonia	−51.7	6.5	−62.9 to −40.4	0.000
Effect on May 1–15, 2020				
Total	−326.7	28.7	−376.4 to −277.1	0.000
Bronchiolitis	−125.4	47.3	−207.2 to −43.6	0.016
Asthma	−63.1	10.6	−81.3 to −44.8	0.000
Pneumonia	−55.3	7.2	−67.8 to −42.8	0.000
Effect on May 16–31, 2020				
Total	−356.7	36.3	−419.4 to −294.1	0.000
Bronchiolitis	−146.6	55.7	−242.8 to −50.3	0.016
Asthma	−71.1	13.0	−93.6 to −48.6	0.000
Pneumonia	−59.0	9.1	−74.7 to −43.3	0.000

[a]The means of the ages were higher in 2020 in comparison to other years in the post hoc analysis of variance analysis.

[b]For length of stay, means were lower in 2020, when compared with other years.

Ljung-Box Q for all the models ($p > 0.005$).

The coefficient estimates for the effects of intervention represent the variations in the number of total PICU admissions, and for the diagnosis of bronchiolitis, asthma, and pneumonia, in 2020. Dashes indicate data not applicable.

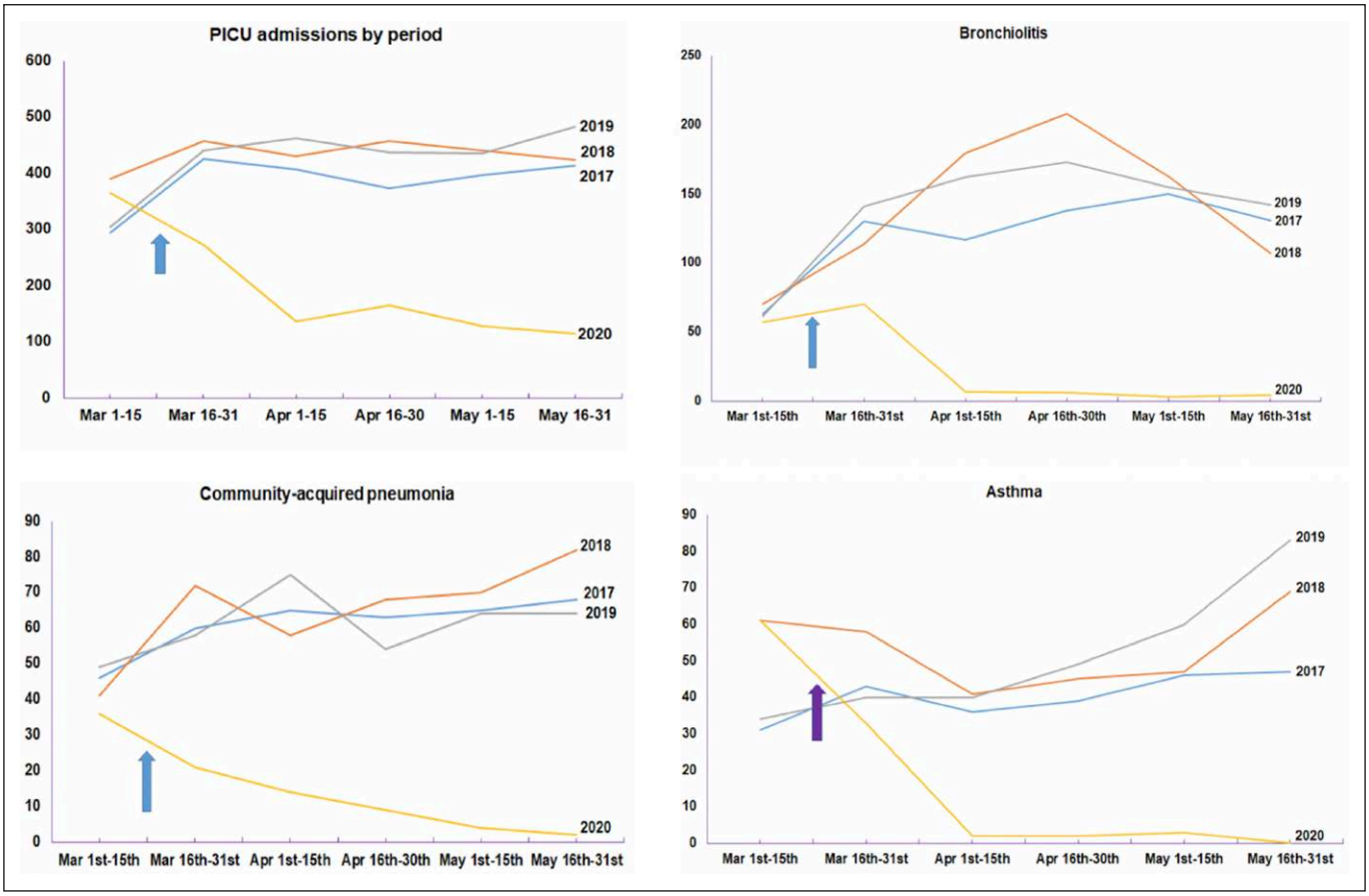

Figure 1. Impact of physical distancing in the general number of PICU admissions and in some more prevalent respiratory diseases. **A**, PICU admissions by period; (**B**) bronchiolitis admissions by period; (**C**) community-acquired pneumonia by period; and (**D**) asthma admissions by period. The *arrow marks* the point of intervention, that is, the physical distancing, quarantine, and the suspension of school activities.

The COVID-19 pandemic has also profoundly affected the routine of Brazilian PICUs. The combination of reduced admissions with reduced length of stay resulted in low occupancy rates, compromising financial viability. Some PICUs were closed, and a part of pediatric intensivists was employed in adult ICUs to treat adult patients with COVID-19. Although there is a lack of data, we suppose the same scenario may be happening in other countries.

This study has several limitations. Although it was a multicenter study, involving several regions of Brazil, it may not be representative of all Brazilian PICUs, since it was a sample that included only private hospitals not covering all Brazilian regions. However, the admissions due to bronchiolitis, for example, do not suffer so much from the influence of socioeconomic factors. Another issue is the lack of data about the financial impact of the COVID-19 pandemic in pediatric hospitalizations, which is an important variable to be studied. Last, it was a retrospective study that employed a web-based data source lacking important information to complement the study, such as how the staff was deployed; if they remained in the PICU or moved to other areas of the hospital. For the same reason, there is a lack of data about any out-of-hospital arrangements in community facilities or physician's offices, or even the use of social media platforms to mitigate the COVID-19 pandemic.

CONCLUSIONS

The COVID-19 pandemic strongly affected Brazilian PICUs, reducing admissions, length of stay, and the epidemiological profile. The measures to oppose the COVID-19 pandemic may have prevented thousands of PICU hospitalizations across the country.

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The authors have disclosed that they do not have any potential conflicts of interest.

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