



Impact of the COVID-19 Pandemic on Pediatric Intensive Care Unit Admissions: A Single Centre Experience

✉ Pinar Yazıcı Özkaya¹, ✉ Hatice Feray Arı¹, ✉ İlke Baş², ✉ Eşe Eda Turanlı¹, ✉ Bülent Karapınar¹

¹Ege University Faculty of Medicine, Department of Pediatrics, Division of Pediatric Intensive Care, İzmir, Turkey

²Ege University Faculty of Medicine, Department of Pediatrics, İzmir, Turkey

ABSTRACT

Aim: During the coronavirus disease-2019 (COVID-19) pandemic, pediatric emergency department visits and pediatric intensive care unit (PICU) admissions were significantly decreased. This study aimed to evaluate the impact of prevention strategies on PICU admissions during the COVID-19 outbreak.

Materials and Methods: We included all patients admitted to a PICU from March 15th to September 15th, 2020, and those admitted in the same period in 2019. Incidence rates ratios (IRR) between the 2019 and 2020 cohorts (IRR-1) and restriction periods (March 2020-June 2020) and post-restriction periods (July 2020-September 2020) (IRR-2) were computed using Poisson modelling according to the data distribution. We analyzed the number of PICU admissions and the patient characteristics.

Results: A total of 437 patients from 465 admissions were included. In 2020, the number of PICU admissions significantly decreased by 65% compared to 2019 [0.355 (0.287-0.440)]. During the restriction period, the number of PICU admissions was significantly lower by 40.3% compared to the post-restriction period [0.597 (0.493-0.722)]. Lower respiratory tract infections (LRTIs) significantly decreased by 19% in the post-restriction period compared to the restriction period [0.811 (0.684-0.960)]. Cardiopulmonary arrests before PICU admission were significantly higher during the restriction period compared to the post-restriction period (15.5% vs 4.8%, $p < 0.015$).

Conclusion: It was shown that there was a significant decrease in all PICU admissions, especially those due to LRTIs during the COVID-19 period. During the restriction period, cardiopulmonary arrest prior PICU admission was higher compared to the post restriction period and 2019. Our study does not reveal an increase in illnesses severity scores but the significant increase in cardiopulmonary arrest may be explained by a delay in health care access and fear of COVID-19 transmission.

Keywords: COVID-19, children, pediatric critical care, quarantine

Introduction

The coronavirus disease-2019 (COVID-19) started as an epidemic in Wuhan in 2019, and the World Health Organization announced on March 11th 2020 that the outbreak of COVID-19 had become a pandemic. After the first attack of COVID-19, most countries went under strict

quarantine in March 2020. In Turkey, restrictions on mobility at the population level and regional quarantine applications were introduced. Schools and sport activities were shut down in March 16th 2020 and going out was restricted to 3 hours and then to 4 hours for children.

In addition to these restrictions, with the protective effect of social distancing and masks, a decrease in infections

Address for Correspondence

Hatice Feray Arı, Ege University Faculty of Medicine, Department of Pediatrics, Division of Pediatric Intensive Care, İzmir, Turkey
Phone: +90 232 390 15 63 E-mail: dr.hferayyavas@gmail.com ORCID: orcid.org/0000-0002-2208-2524

Received: 02.08.2021 Accepted: 23.12.2021

©Copyright 2022 by Ege University Faculty of Medicine, Department of Pediatrics and Ege Children's Foundation
The Journal of Pediatric Research, published by Galenos Publishing House.

due to other viral causes was detected in children during this period (1,2). Studies showed that trauma patients and pediatric emergency department admissions decreased, especially during the periods of curfews (3,4). During the pandemic, parents avoided emergency department admission due to the risk of COVID-19 transmission. This caused children to be admitted to the hospital with a higher risk of severe illnesses.

With this study, we aimed to evaluate the influence of the COVID-19 measures on the rates, types and severities of pediatric intensive care unit (PICU) admissions.

Materials and Methods

Patients

We performed a retrospective single center study comparing the periods March 15th - September 15th in 2019 and in 2020. We included all admission to a PICU which is a 17-bed medical and surgical unit. All of the available medical records of the patients were reviewed. Their demographic characteristics, medical history, comorbidity, discharge diagnosis, need for mechanical ventilation support, duration of positive pressure ventilation, and length of stay in the PICU were recorded. The severity of illness was measured by means of the Pediatric Risk of Mortality-3 (PRISM3) score at PICU admission. We excluded "early re-admissions" which are defined as re-admission within 48 hours of PICU discharge and those patients who were discharged within 24 hours.

Diagnoses at admission were categorized into 8 subgroups: (1) Respiratory failure including lower respiratory tract infections (LRTIs) and asthma; (2) Heart failure including congenital and acquired cardiovascular disease; (3) Encephalopathy/seizure including convulsion, meningitis/encephalitis; (4) Sepsis; (5) Trauma and intoxication; (6) Surgery including planned and unplanned surgery; (7) Metabolic/dehydration including acute gastroenteritis, renal failure, hepatic failure, diabetic ketoacidosis; and (8) Other including acute leukemia, left ventricular assist device thrombosis and others.

Ethical approval was obtained from Ege University Faculty of Medicine Clinical Research Ethics Committee for this study (ethics committee number: 21-2T/65).

Statistical Analysis

Statistical analysis was performed with SPSS statistical package for Windows 22.0. Descriptive data were reported in terms of absolute frequencies for categorical variables, and in terms of medians and interquartile ranges (IQR)

for continuous variables. For the analysis of independent continuous variables, Student's t-test was used under parametric, and Mann-Whitney U test under non-parametric conditions. Chi-square analysis was used for categorical variables. Differences were considered significant at $p < 0.05$. The difference in incidence rates ratios (IRR) and their 95% confidence intervals (CIs) between the 2019 and 2020 cohorts (IRR-1), and the restriction (March 15th, 2020-June 15th, 2020) and post-restriction (July 15th, 2020-September 15th, 2020) (IRR-2) periods were computed using Poisson modelling according to the data distribution. The relative variation in the number of cases between the two periods were calculated as the difference between the two periods divided by the number of cases in the 2019 for the 2020 cohort and, the number of cases in the restriction cohort for the post-restriction cohort. Statistical significance was set with a two-sided p -value < 0.05 .

Results

We evaluated 437 patients who had 465 PICU admissions. During the study period in 2019, the number of PICU admission was 289. In 2020, the number of PICU admissions significantly decreased by 65% compared to 2019 [IRR-1 0.355 (0.287-0.440)]. Patient characteristics, types and frequencies of PICU admissions, and estimates of IRRs are shown in Table I. During the restriction period, the number of PICU admissions was significantly lower by 40.3% compared to the post-restriction period [IRR-2 0.597 (0.493-0.722)].

The median age was 35 months in the 2019 cohort (IQR 9-106), and 43 months (IQR 10-142.7) in the 2020 cohort. There were no statistically significant differences in the age groups (<1 year, 1-6 years, >6 years) between 2019 and 2020. PRISM score, length of PICU stay and length of positive pressure ventilation were similar in 2019 and 2020. The demographic and clinical data of PICU admissions are shown in Table II. Cardiopulmonary arrest before PICU admission was significantly higher during the restriction period compared to the post-restriction period (15.5% vs 4.8%, $p < 0.015$). Cardiopulmonary arrest before PICU admission did not significantly change between 2019 and 2020 (6.9%, 9.1% respectively, $p = 0.396$).

In the comparison of the admission diagnosis groups, there was no statistically significant difference between 2019 and 2020 and between the restriction and post-restriction periods. LRTIs in the post-restriction period significantly decreased by 19% compared to the restriction period [0.811 (0.684-0.960)]. Intra-hospital ward, planned

and unplanned surgical admissions did not significantly change. Patients admitted for diabetic ketoacidosis in the restriction period were lower by 25% compared to the post-restriction period [0.752 (0.562-1.005)], but this did not reach statistically significant levels ($p=0.054$).

Discussion

Since the COVID-19 outbreak, the rates of hospital admissions decreased in the pediatric patient group. Our study revealed that the rate of PICU admissions, especially due to LRTIs, decreased significantly. After the COVID-19 epidemic, it was seen that hospitalizations to both pediatric emergency departments and PICUs decreased and the patients' epidemiological characteristics changed. Although the decrease in emergency room admissions due to trauma and viral infections can be explained by the curfews, social distancing and the interruption of sports activities, the decreases in admissions to the pediatric intensive care unit cannot be explained by these factors alone.

During the peak period of the pandemic, mandatory quarantine and strict restrictions were imposed in many countries in order to control the spread of COVID-19. In Turkey, collective measures were implemented in the middle of March 2020, namely social distancing, mandatory mask wearing and school closures. In mid-April, a national mandatory quarantine application was initiated throughout the country during weekends. In June 2020, intercity travel

restrictions ended and a normalization process started. Contrary to this situation, we found that those patients admitted for LRTIs decreased by 19% during the post-restriction period. We speculate that the measures such as mandatory masks, hand hygiene, social distancing and the closure of places where children have closer contact such as shopping malls and schools are more effective in reducing the number of patients with LRTIs than strict curfews. Previous studies reported a significant reduction in PICU admissions due to LRTIs (52-83%) between 2019 and 2020 (2,5). In our study, we did not see any difference between these periods.

In studies evaluating PICU admissions, a significant decrease was reported in hospitalization rates due to bronchiolitis, asthma, and community-acquired pneumonia, but no change was seen in epilepsy, diarrhea, sepsis, bacterial meningitis, diabetic ketoacidosis and surgical patient groups (6,7). In our study, when the specific diagnosis subgroups were evaluated, no difference was found in the rates of admissions due to trauma and suicide. A statistically insignificant decrease in PICU admissions due to diabetic ketoacidosis was detected during the restriction period. Although it was reported that the number of patients diagnosed with traumatic brain injury decreased in the adult patient group during the period of full quarantine, no significant difference was found in our study in the number of pediatric patients who were admitted to PICU due to trauma (3). In Italy,

Table I. Patient characteristics, type and frequency of pediatric intensive care unit, and estimates of incidence rate ratios (IRR)

Variable	IRR-1 (95% CI) (2019 vs 2020)	p-value	IRR-2 (95% CI) (restriction vs post restriction 2020)	p-value
Admissions	0.355 (0.287-0.440)	<0.001	0.597 (0.493-0.722)	<0.001
Gender (female)	1.098 (0.814-1.481)	0.542	1.032 (0.700-1.521)	0.874
Age				
0-1 year	1.006 (0.101-10.024)	0.996	0.829 (0.522-1.314)	0.424
1-6 years	0.899 (0.092-8.810)	0.927	0.740 (0.463-1.181)	0.207
>6 years	1.113 (0.114-10.908)	0.927	1	
Type of admission				
Extra-hospital	0.875 (0.573-1.336)	0.536	1.032 (0.571-1.865)	0.916
Intra-hospital, ward	1.202 (0.871-1.657)	0.263	1.293 (0.855-1.957)	0.223
Diagnosis at discharge				
LRTIs	1.225 (0.879-1.707)	0.231	0.811 (0.684-0.960)	0.015
Trauma	1.040 (0.696-1.555)	0.847	0.911 (0.739-1.122)	0.379
Planned surgery	1.116 (0.734-1.697)	0.607	1.835 (0.493-6.831)	0.366
Unplanned surgery	0.720 (0.390-1.331)	0.295	2.002 (0.459-8.739)	0.356
Diabetic ketoacidosis	1.47610 (0.818-2.664)	0.196	0.752 (0.562-1.005)	0.054
Suicide	0.934 (0.047-0.461)	0.894	1.339 (0.400-4.480)	0.636
Comorbidity	1.184 (0.878-1.597)	0.267	1.252 (0.763-2.054)	0.374

IRR-1; March 15th - September 15th 2019 vs March 15th - September 15th 2020, IRR-2; restriction (March 15th, 2020-June 15th, 2020) vs post-restriction (July 15th, 2020-September 15th, 2020), CI: Confidence interval, LRTIs: Lower respiratory tract infections

following the national lockdown, a statistical significant decrease of ED visits due to accidents was observed for all types of injury groups except for injury in the domestic environment (8). This can be explained by the fact that the full quarantine application was not initiated in our country. Although it was determined that elective surgical operations were postponed and the total number of surgical procedures decreased during the COVID-19 outbreak, no significant decrease was shown in the number of patients admitted to PICU for planned or unplanned surgery.

The significant decrease in admissions to pediatric health care services due to a fear of COVID-19 has raised concerns that patients will access health care at a later date and so with a higher risk of severe illness. During the peak of the COVID-19 outbreak, pediatric ED visits significantly decreased especially for minor reasons (4,9). In a previous study, it was noted that the proportion of children presenting at an ED with high acuity was 25% greater and low-acuity was 15% lower in the peak lockdown period compared to the previous year (9). In a small series of 12 cases whose parents reported avoiding accessing hospital because of a fear of infection due to SARS-CoV-2, 50% of patients were admitted to PICU and 33.3% died (10). Our findings revealed that PRISM scores,

mortality rates and comorbidities did not significantly change during the COVID-19 pandemic. However, during the restriction period, cardiopulmonary arrest before PICU admission significantly increased. Detailed evaluation revealed that 6 patients presented with respiratory failure and their symptoms continued for 3-6 days and 8 patients did not have any previous hospital admissions during their illness. The mortality rate of 11 patients with a history of cardiopulmonary arrest before admission was 63.4%, and the accompanying comorbidity rate was 45.4%. These findings are similar to the data that indicates that the fear of COVID-19 contact increases mortality by delaying hospital admissions.

Study Limitations

This study has several limitations, mainly as a result of its retrospective design. Although the patient data were collected from an electronic database, a small amount of data was missing. Statistical analysis was made on the complete data. Despite the center where the study was conducted serving a large region due to its status as a reference university hospital, our findings may not reflect all PICUs in Turkey due to the single center nature of our study data.

Variable	2019 n=289	2020 n=176	p-value	March-May 2020 n=71	June-August 2020 n=105	p-value
Age, months (median, IQR)	35 (9-106)	43 (10-142.7)	0.233	27.0 (10-98)	53 (10.5-154)	0.122
Gender (Female/Male)	113/176	75/101	0.454	30/41	45/60	0.937
PRISM	7 (3-11)	9.0 (2-16)	0.129	10.5 (2-18)	8 (1-16)	0.360
Death probability (%, median, IQR)	3.4 (1.5-7.6)	5.1 (1.3-18.7)	0.136	6.2 (1.3-25.8)	4.2 (1-18.7)	0.353
PICU length of stay (day, median, IQR)	4 (2-8)	5 (2-11.25)	0.207	4 (1.5-10.5)	5.0 (2-12)	0.179
PPV day (median, IQR)	3.0 (2-6.5)	4.0 (2-12)	0.201	3 (2-10)	6.5 (2-17)	0.063
Cardiopulmonary arrest before admission (n, %)	20.0 (6.9%)	16.0 (9.1%)	0.396	11 (15.5%)	5 (4.8%)	0.015*
Diagnosis at admission (n, %)						
Respiratory failure	67 (23.2)	48 (27.8)	0.269	25 (35.2)	24 (22.9)	0.073
Heart failure	36 (12.5)	15 (8.5)	0.184	6 (8.5)	9 (8.6)	0.978
Encephalopathy, seizure	39 (13.5)	16 (9.1)	0.150	4 (5.6)	12 (11.4)	0.190
Sepsis	32 (11.1)	19 (10.8)	0.916	5 (7.0)	14 (13.3)	0.187
Trauma, intoxication	63 (21.8)	33 (18.8)	0.420	12 (16.9)	21 (20)	0.605
Surgical	22 (7.6)	16 (9.1)	0.580	5 (7)	11 (10.5)	0.437
Metabolic/dehydration	22 (7.6)	22 (12.5)	0.083	10 (14.1)	12 (11.4)	0.631
Others	7 (2.4)	6 (3.4)	0.570	4 (5.6)	2 (1.9)	0.181

*Odd ratio: 1.127 (95% CI 1.011-1.256)
IQR: Interquartile range, PRISM: Pediatric risk of mortality, PPV: Positive pressure ventilation, CI: Confidence interval

Conclusion

In conclusion, in our study, it was shown that there was a significant decrease in all PICU admissions especially due to LRTIs during the COVID-19 period. Although there was no difference in terms of disease severity, it is thought that the high cardiopulmonary arrest prior to PICU admission in the first 3 months of the pandemic was due to an avoidance of admission to the health center and consequent later admission.

Ethics

Ethics Committee Approval: Approval was obtained from Ege University Faculty of Medicine Clinical Research Ethics Committee for this study (ethics committee number: 21-2T/65).

Informed Consent: Informed consent was obtained from the families.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: P.Y.Ö., H.F.A., E.E.K., Concept: P.Y.Ö., B.K., Design: P.Y.Ö., B.K., Data Collection or Processing: E.E.K., İ.B., Analysis or Interpretation: P.Y.Ö., B.K., Literature Search: P.Y.Ö., H.F.A., Writing: P.Y.Ö., B.K.

Conflict of Interest: The authors declare that they have no conflict of interest.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Friedrich F, Ongaratto R, Scotta MC, et al. Early Impact of Social Distancing in Response to Coronavirus Disease 2019 on Hospitalizations for Acute Bronchiolitis in Infants in Brazil. *Clin Infect Dis* 2021; 72:2071-5.
2. Vásquez-Hoyos P, Diaz-Rubio F, Monteverde-Fernandez N, et al. Reduced PICU respiratory admissions during COVID-19. *Arch Dis Child* 2020:archdischild-2020-320469.
3. Pinggera D, Klein B, Thomé C, Grassner L. The influence of the COVID-19 pandemic on traumatic brain injuries in Tyrol: experiences from a state under lockdown [published online ahead of print, 2020 Jul 22]. *Eur J Trauma Emerg Surg*. 2020;1-6. doi:10.1007/s00068-020-01445-7
4. Iozzi L, Brambilla I, Foadelli T, Marseglia GL, Ciprandi G. Paediatric emergency department visits fell by more than 70% during the COVID-19 lockdown in Northern Italy. *Acta Paediatr* 2020; 109:2137-8.
5. Sperotto F, Wolfler A, Biban P, et al. Unplanned and medical admissions to pediatric intensive care units significantly decreased during COVID-19 outbreak in Northern Italy. *Eur J Pediatr* 2021; 180:643-8.
6. Araujo OR, Almeida CG, Lima-Setta F, Prata-Barbosa A, Colleti Junior J; Brazilian Research Network in Pediatric Intensive Care (BRnet-PIC). The Impact of the Novel Coronavirus on Brazilian PICUs. *Pediatr Crit Care Med* 2020; 21:1059-63.
7. Graciano AL, Bhutta AT, Custer JW. Reduction in paediatric intensive care admissions during COVID-19 lockdown in Maryland, USA. *BMJ Paediatr Open*. 2020; 4:e000876.
8. Raucci U, Musolino AM, Di Lallo D, et al. Impact of the COVID-19 pandemic on the Emergency Department of a tertiary children's hospital. *Ital J Pediatr* 2021; 47:21.
9. Goldman RD, Grafstein E, Barclay N, Irvine MA, Portales-Casamar E. Paediatric patients seen in 18 emergency departments during the COVID-19 pandemic. *Emerg Med J* 2020; 37:773-7.
10. Lazzerini M, Barbi E, Apicella A, Marchetti F, Cardinale F, Trobia G. Delayed access or provision of care in Italy resulting from fear of COVID-19. *Lancet Child Adolesc Health* 2020; 4:e10-1.