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The flow pattern of neuro-pediatric emergency visits during COVID-19 pandemic

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Abstract

Background COVID-19 is a global pandemic that has highly impacted the healthcare system and patients, especially patients with epilepsy, due to the fact that the success of their treatment depends on obtaining sustainable access to medical professions, diagnostic services, facilities, and medications. The epidemiology and presence of neuro-pediatric emergencies in the setting of COVID-19 in XXX have not been thoroughly described. This is a barrier to planning and providing quality emergency care within the local health systems. The objective of this study is to provide a comprehensive description of the epidemiology of neurological cases encountered in the pediatric emergency unit.

Methods This is a retrospective study to analyze the flow pattern of Emergency Department (ED) visits among pediatric patients with neuro-related complaints. Participants were filtered, and a total of 108,000 visits were reduced to 960 patients with a neurological provisional diagnosis. Patients were grouped into pre- and post-pandemic visits according to their age group. We identified demographic and clinical variables.

Results The study included 960 patients with a provisional neurological diagnosis, consisting of 542 (56.5%) males and 418 (43.5%) females. The mean age of admission was 5.29 ± 4.19 years. The majority of patients were triaged as "priority 1—resuscitation" (n = 332, 34.6%), and seizures were the most frequent chief complaint (n = 317, 33.0%). Statistical significance was observed for patients with vascular issues (p = 0.013) during the pre-COVID-19 period after adjusting for odds ratio. The most common outcome was discharge (n = 558, 58.1%). The mean length of stay during the pre-COVID-19 pandemic was 16.48 ± 33.53 h, which was significantly longer compared to a mean length of stay of 7.76 ± 7.27 h during the COVID-19 pandemic (P < 0.001).

Conclusion We presented a new epidemiology of pediatric patients with neuro-related ED visits. An increase in seizure diagnosis was observed, as were significant shifts in the length of stay. Demographic changes were less evident in the two periods. Understanding such variation aids in managing this vulnerable population during critical periods.

Keywords Emergency medicine, Epilepsy, Chief complaint

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Introduction

COVID-19 is a global pandemic caused by the Human Coronavirus (HCoV) SARS-CoV-2 that was first reported in Wuhan, China, on December 19, 2019 and began to spread across the globe, causing catastrophic consequences [1]. On March 11, 2020, the World Health Organization (WHO) declared it a global pandemic [2]. The COVID-19 pandemic has disproportionately impacted patients with mental-related disorders in pediatric healthcare centers, especially female children and patients living in socioeconomically disadvantaged areas [3]. Patients with epilepsy (PWE) are also among the patients that were highly impacted during the pandemic. This is due to the fact that the success of their treatment depends on obtaining sustainable access to medical professions, diagnostic services, healthcare facilities, and the availability of Antiseizure Medications (ASMs) [4]. Globally, several studies pointed to an overall decline in emergency department (ED) visits during the pre-pandemic and pandemic periods [5–7]. Furthermore, the suspension of usual clinical visits was reported by Cesario et al., leading to impeded caregiving [8]. In clinical practice, patients' volume is one factor among many. Symptoms and severity are equally important, especially among the younger population. Compared to adults, it has been reported that children develop mild symptoms of COVID-19 or even remain asymptomatic [9]. However, in children younger than 55 days, severe illness has been reported. [10] and in some cases, neurological signs have been reported, with some cases presenting with neurological squeals [11]. COVID-19 may not be the cause of neurological symptoms in children, but it has an impact on patients with chronic neurological diseases, as a study concluded that the pandemic caused a reorganization of healthcare settings and so affected the well-being of families caring for pediatric neurologic symptoms [8]. Generally, neurological symptoms are common medical problems presenting to the EDs prior to and during the pandemic. The epidemiology and presence of neuro-pediatric emergencies in the setting of COVID-19 in XXX have not been thoroughly described. This is a barrier to planning and providing quality emergency care within the local health systems. We performed a retrospective study to describe the epidemiology of neurological cases encountered in the Pediatric Emergency Unit (PEU) at a busy tertiary care center.

Methods

Ethical approval

The study's aim, protocol, and procedure were approved by the Unit of Biomedical Ethics Research Committee of XXX with reference number (324–23) on June 20, 2023. The study was conducted according to the World Medical Association Declaration of Helsinki. All revealing data was masked, and patients' privacy was ensured throughout the conduct of the study.

Study design and setting

We retrospectively reviewed and extracted data from a single tertiary care hospital following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist [12] to analyze the flow pattern of ED visits among pediatric patients with neuro-related complaints during the prior COVID-19 pandemic. The tertiary care center is a publicly funded and owned center that serves the entire community with a bed capacity of 750 beds and up to 900 beds in an emergency setting and receives an estimated 60,000 visits annually. It has specialized units and services for neurological complaints. The data was directly extracted from the electronic hospital record system after obtaining technical and ethical clearance. Participants were filtered after applying the inclusion criteria to include pediatric patients with a neurological provisional diagnosis. The neurological provisional diagnosis included the following: seizure or epilepsy, headache or loss of consciousness, inflammation, cranial nerve palsy, neuromuscular, neoplasm, vascular, injury, and abscess. All these diagnoses were related to or affected the nervous system. Subsequently, a total of 108,000 visits were reduced to 960 patients. Patients were later divided into two groups: pre- (n = 309) and during the (n = 651) COVID-19 pandemic. As for the determination of the start of the COVID-19 pandemic, the date of the first case detected nationwide was set as the start of the pandemic. Time periods prior to that were labeled pre-pandemic. The pediatric age groups were defined by the National Institute of Child Health and Human Development as follows: (A) Neonate (birth–1 month); (B) Infancy (1 month–1 year); (C) Toddler (1–3 years); (D) Preschool (3–6 years); (E) School age (6–12 years); and (F) Adolescent (12–18 years) using the standardized labeling according to the center's clinical practice. We identified demographic characteristics, including their gender, nationalities, triage priority, provisional diagnosis, clinical outcome, chief complaint, length of stay (LOS), investigations (i.e., X-Ray, Computerized tomography *scan, Magnetic resonance imaging,* lab workup), and number of medications. The triage level categorization that was determined in this study was done using the Australasian Triage Scale (ATS). Furthermore, it was adopted in accordance with local standardized triage protocols and guidelines set by our center. These protocols classify patients based on how urgently they need medical care in order to ensure patient safety and effective resource allocation.

Statistical analysis

Descriptive statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA) and SmartPLS 3 to test the relationship between the variables. Quantitative variables were described using measures of central tendency. Categorical variables, on the other hand, use frequencies and percentages. A chi-square test was applied to categorical variables for comparison. One-way analysis of variance (ANOVA) and multilinear logistic regression were used to predict the difference between the data during and prior to the pandemic. All data utilized graphical presentation in the form of line charts and illustrated graphs. All P-values < 0.05 and 95% confidence intervals were considered to be statistically significant.

Results

Demographics and clinical characteristics

The study included 960 patients with a provisional neurological diagnosis, as described in the methodology section. Table 1 presents the baseline characteristics of the patients. There were 542 (56.5%) male patients in comparison to 418 (43.5%) female patients. The mean age of the patients during the admission was 5.29 ± 4.19 years. The most common age group was the school-age group (6–12 years), which comprised 279 (29.1%) of the patients. The majority of patients were triaged as "priority 1: resuscitation". (n = 332, 34.6%), followed by "Priority 3: Urgent" (n = 331, 34.5%).

Table 2 demonstrates a comparison of different characteristics between the pre-COVID-19 pandemic and the COVID-19 pandemic.

Patients' complaints

The most common chief complaint was seizures (n = 317, 33.0%), followed by patients presenting in the post-ictal state (n = 187, 19.5%). Most patients received a provisional diagnosis of seizures/epilepsy (n = 529, 55.1%). When comparing both eras, a statistically significant difference in the most common chief complaints was observed ($P = 0.005$) (Table 2). However, there was no statistically significant difference in the provisional diagnosis ($P = 0.232$) (Table 2). Table 3 demonstrates a multinomial logistic regression that compares the pre-COVID-19 era to the time of the COVID-19 pandemic according to a specific provisional diagnosis. During the pre-COVID-19 era and after adjusting the odds ratio, statistical significance was observed for patients complaining of vascular issues ($P = 0.013$). Similarly, it was significant during the COVID-19 pandemic ($P = 0.013$). Other values were presented in Table 3.

Table 1 Baseline characteristics of 960 patients

Characteristic	
Age, in years (mean ± SD)	5.29 ± 4.19
Age groups, n (%)	
Neonate (birth–1 month)	25 (2.6)
Infancy (1 month–1 year)	163 (17)
Toddler (1–3 years)	196 (20.4)
Preschool (3–6 years)	200 (20.8)
School age (6–12 years)	279 (29.1)
Adolescent (12–18 years)	97 (10.1)
Gender, n (%)	
Male	542 (56.5)
Female	418 (43.5)
Nationality, n (%)	
XXX	447 (46.6)
XXX	513 (53.4)
Triage, n (%)	
Priority 1—Resuscitation	332 (34.6)
Priority 2—Emergent	280 (29.2)
Priority 3—Urgent	331 (34.5)
Priority 4—Less Urgent	11 (1.1)
Priority 5—Non-Urgent	6 (0.6)
Outcome, n (%)	
Discharged	558 (58.1)
Admitted	394 (41.0)
AMA (Against Medical Advice)	4 (0.4)
LBT (Left Before Treatment)	3 (0.3)
Deceased (Hospital Death)	1 (0.1)
Provisional diagnosis n (%)	
Seizure/epilepsy	529 (55.1)
Headache/loss of consciousness	23 (2.4)
Inflammation	59 (6.1)
Cranial nerve palsy	59 (6.1)
Neuromuscular	14 (1.5)
Neoplasm	55 (5.7)
Vascular	92 (9.6)
Injury	128 (13.3)
Abscess	1 (0.1)
Most common chief complaints, n (%)	
Seizures	317 (33.0)
Post-ictal	187 (19.5)
Fever	84 (8.8)
Head injury	75 (7.8)
Shortness of breath	35 (3.6)
Vomiting	35 (3.6)
Trauma	29 (3.0)
Headache	26 (2.7)
Weakness	23 (2.4)
Swelling	20 (2.1)
Length of stay, n (%)	
Less than 24 h	896 (93.3%)
24–48 h	39 (4.1%)

Table 1 (continued)

Characteristic	
More than 48 h	25 (2.6%)
Length of stay in hours (mean ± SD)	10.56 ± 20.33
Investigations (mean ± SD)	
X-Ray	0.48 ± 0.94
Computerized tomography *scan*	0.50 ± 0.77
Magnetic resonance imaging	0.05 ± 0.34
Labs	8.53 ± 6.39
Medications (mean ± SD)	3.19 ± 4.15

Patients' outcomes

The most common outcome was discharge (n = 558, 58.1%), followed by admission (n = 394, 41.0%). The mean length of stay was 10.56 ± 20.33 h, and the majority of the patients stayed for less than 24 h (n = 896, 93.3%) (Fig. 1). When comparing between both eras according to the outcome, a statistically significant difference was not found (P = 0.587). The mean length of stay during the pre-COVID-19 pandemic was 16.48 ± 33.53 h, in contrast to a shorter mean length of stay of 7.76 ± 7.27 h during the COVID-19 pandemic ($P < 0.001$) (Table 2).

Discussion

In this study, we investigated the effect and impact of COVID-19 on the flow pattern of ED visits related to the pediatric population and presenting with a neurological complaint. Many studies were conducted to assess the change in the flow pattern and hospitalization [13–16]. However, these studies addressed the general pediatric population, primarily focusing on respiratory-related patients. Nonetheless, studies addressing the effect of the pandemic on pediatric neurology admissions do exist but address other aspects, including the utilization of telemedicine during the pandemic era [17, 18]. Furthermore, in our local literature, no studies have measured the effect of the pandemic on pediatric neurology cases despite the high volume of admissions, making this article and its data of important necessity. In this study, in which 960 visits were analyzed, we found that 309 visits were recorded during the pre-COVID-19 era, while 651 cases were recorded during COVID-19. In comparison, other studies had an average of 823 visits during the pre-COVID-19 era and 339 visits during the COVID-19 era [15]. Moreover, Gavish et al. recorded 587, 638, and 258 visits during the years 2018, 2019, and 2020, respectively [14]. The mean age of patients in our study was 5.29 ± 4.19 years, suggesting that the majority of patients present at a very early age. This echoes the findings of Devrim et al., who found a mean age of 4 years among some pediatric groups. [19] The highest number of visits according to age group was among school-age patients (n = 279) in comparison to the higher number of visits among adolescents in the literature [13].

There were no significant differences according to the patients' gender (P-value = 0.212), which was similar to the literature findings [15]. However, this was not the case regarding the LOS, in which our study presented statistical significance (P-value = 0.000) compared to other studies [15]. Other studies which investigated specific pediatric groups showed significant changes in the LOS of their patients ($P < 0.001$). [13] Also, the LOS in hours decreased by 47.0% during the pandemic, as the median duration for the length of stay in our study was 16.48 ± 33.53 in the pre-pandemic period and 7.76 ± 7.27 during the pandemic. This can be attributed to the measures taken against the COVID-19 disease during the pandemic and people being protective, resulting in reduced hospital presentations and admissions.

However, in literature studies, variability in the LOS was observed. During COVID-19, an increase in the LOS was seen in resuscitation areas in contrast to

Table 2 Chi square test comparing the pre and during COVID19 pandemic eras

Characteristic	Pre-COVID (n = 309)	During COVID (n = 651)	*P-value*
Age, in years (mean ± SD)	5.49 ± 4.21	5.19 ± 4.19	0.289
Age groups	309 (32.19)	651 (67.81)	0.523
Gender			0.212
Nationality			0.958
Triage priority			0.716
Clinical outcome			0.587
Provisional diagnosis			0.232
Common presenting complaints			0.005
Length of stay			0.000
Investigations			0.000

Table 3 Multilinear logistical regression comparing the pre and during COVID-19 era in reference to patients' provisional diagnosis

	Provisional diagnosis	P-value	Crude Odds ratio	95% Confidence interval		P-value	Adjusted odds ratio	95% Confidence interval	
				Lower value	Upper value			Lower value	Upper value
Pre-COVID19	Seizure/epilepsy	0.175	0.821	0.625	1.077	0.129	0.767	0.545	1.080
	Headache/loss of consciousness	0.190	0.436	0.147	1.293	0.124	0.405	0.128	1.280
	Inflammation	0.664	1.176	0.678	2.041	0.637	0.851	0.437	1.660
	Cranial nerve palsy	0.313	1.374	0.799	2.361	0.281	1.377	0.770	2.465
	Neuromuscular	1.000	1.173	0.390	3.531	0.614	1.335	0.435	4.100
	Neoplasm	0.593	1.218	0.691	2.147	0.950	1.021	0.536	1.945
	Vascular	0.106	1.474	0.949	2.290	*0.013*	1.847	1.140	2.993
	Injury	0.583	0.874	0.582	1.312	0.735	0.924	0.586	1.457
	Abscess	0.703				1.000			
During COVID19	Seizure/epilepsy	0.175	1.219	0.929	1.599	0.129	1.303	0.926	1.835
	Headache / loss of consciousness	0.190	2.292	0.773	6.796	0.124	2.471	0.781	7.816
	Inflammation	0.664	0.850	0.490	1.475	0.637	1.174	0.603	2.289
	Cranial nerve palsy	0.313	0.728	0.423	1.251	0.281	0.726	0.406	1.299
	Neuromuscular	1.000	0.852	0.283	2.565	0.614	0.749	0.244	2.301
	Neoplasm	0.593	0.821	0.466	1.447	0.950	0.980	0.514	1.867
	Vascular	0.106	0.678	0.437	1.054	*0.013*	0.541	0.334	0.877
	Injury	0.583	1.144	0.762	1.717	0.735	1.082	0.686	1.705
	Abscess	0.703							

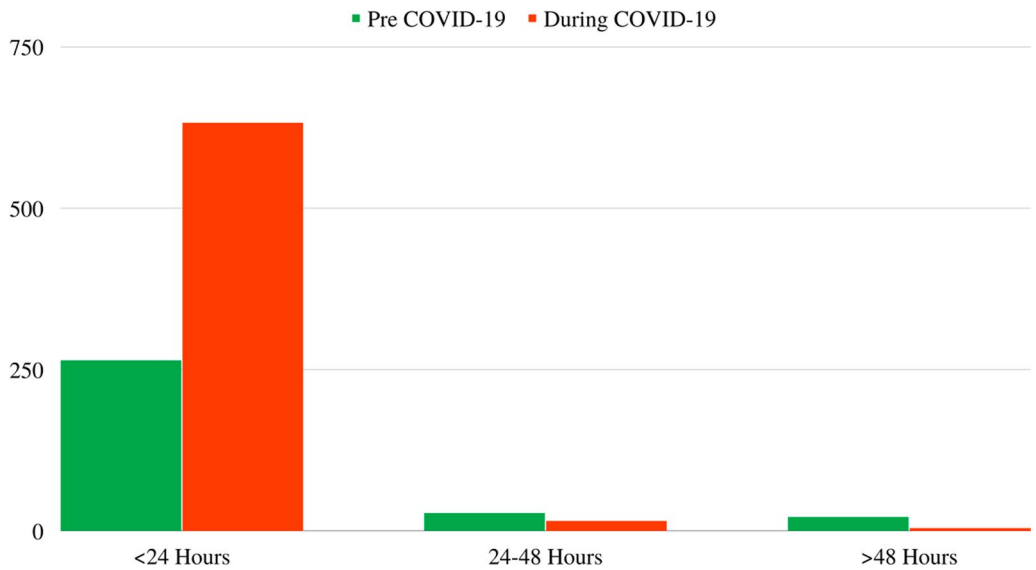

Fig. 1 A comparison of the length of stay in the two studied periods

emergency neurology areas, which showed less change prior to and during the pandemic [20].

Moreover, seizures were a leading complaint in our cohort. Despite this, other studies had fever as a leading complaint and seizures presenting in a fraction of the cases [21]. In the context of the whole pediatric population, it was estimated that nearly one-fourth will present with neurological, psychiatric, and developmental

diseases [16]. According to our findings, the top 10 complaints presenting to the ED remained essentially the same across both periods, with seizures remaining the leading cause of visits before and during the pandemic with 33% and 10.63%, respectively, followed by post-ictal, which accounts for the second most complaints before and during the pandemic with percentages of 15.5% and 21.4%, respectively.

During and prior to the pandemic, diagnoses of seizure or epilepsy were observed in nearly half of the visits. This came in line with the literature, which previously highlighted an increase in the risk, in pediatric patients in particular, of developing seizures after acquiring the COVID-19 infection [22].

Furthermore, the length of stay in hours decreased by 47.0% during the pandemic, as the median duration for the length of stay in our study was 16.48 ± 33.53 in the pre-pandemic period and 7.76 ± 7.27 during the pandemic. This can be attributed to the measures taken against the COVID-19 disease during the pandemic and people being protective, resulting in reduced hospital presentations and admissions.

Conclusion

In conclusion, we presented a new epidemiology of pediatric patients with neuro-related ED visits. Understanding the variations in pediatric ED visits for neuro-related complaints during the pandemic may offer focused possibilities to meet the requirements of this vulnerable population, especially during critical times. There were indeed many shifts caused by the pandemic. Seizures demonstrated a surge during the pandemic, and the LOS significantly shifted between the two periods. Demographic changes were less observed between the two periods, as it seems the pandemic impacted all participants in an equal manner.

Limitations of this study

Due to the study's novelty, the lack of previous studies nationwide made it difficult to compare the findings to others. Moreover, due to the study's design (retrospective), potential missing data and possible inaccurate documentation of patients could impact the study's outcome. These limitations, however, were addressed by significantly increasing the included sample and ensuring a decent representation was achieved.

Abbreviations

ED	Emergency department
HCoV	Human Coronavirus
WHO	World Health Organization
PWE	Patients with epilepsy
ASMs	Antiseizure medications
PEU	Pediatric emergency unit
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology checklist
LOS	Length of stay
SPSS	Statistical package for the social sciences
ANOVA	One-way analysis of variance

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Author contributions

IK and OM: Had a significant role in the idea and the design of the study and reviewed the manuscript. He wrote the protocol, planned, and supervised the study. AA: Designed the study, assisted in data collection, data entry, and shared in the statistical design, and help in writing all the manuscript parts (Introduction, Method, Results, Discussion, Conclusion, Abstract) equally. HA: Designed the study, he assisted in data collection, data entry, and shared in the statistical design, and help in writing all the manuscript parts (Introduction, Method, Results, Discussion, Conclusion, Abstract) equally. MA: She assisted in data collection, data entry, and help in writing all the manuscript parts (Introduction, Method, Results, Discussion, Conclusion, Abstract) equally. MS: She assisted in data collection, data entry, and help in writing all the manuscript parts (Introduction, Method, Results, Discussion, Conclusion, Abstract) equally. She will take the primary responsibility in responding to the reviewers' comments. OA: She assisted in data collection, data entry, and help in writing all the manuscript parts (Introduction, Method, Results, Discussion, Conclusion, Abstract) equally. LA: She assisted in data collection, data entry, and help in writing all the manuscript parts (Introduction, Method, Results, Discussion, Conclusion, Abstract) equally.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study's aim, protocol, and procedure were approved by the Unit of Biomedical Ethics Research Committee of XXX with reference number (324–23) on June 20, 2023. The study was conducted according to the World Medical Association Declaration of Helsinki. All revealing data was masked, and patients' privacy was ensured throughout the conduct of the study.

Consent for publication

Informed consent for publication was obtained from the patient/study participant/parent/guardian.

Competing interests

The authors report no competing interests in this work.

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