

Epidemiologic Trends In Children With Toxicologic Exposures Requiring Intensive Care Before and During the COVID-19 Pandemic

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OBJECTIVE Pediatric poison exposures are a common reason for pediatric intensive care unit (PICU) admission. The purpose of this study was to examine the exposure trends and patient outcomes in 2018–2019 compared with 2020–2021 amidst the COVID-19 pandemic.

METHODS This was a retrospective cohort study of patients 18 years of age or younger with a suspected toxicologic exposure from January 2018 to March 2021. The primary endpoint was rate of PICU admissions between the 2 cohorts. Secondary endpoints included medical outcome stratified by severity, PICU length of stay, and need for mechanical ventilation.

RESULTS Our study included a total of 340 patients with median age 14.5 (IQR, 11.9–16.1) years. There was no significant difference in age, sex, or race between the 2 cohorts. The percentage of patients admitted to the PICU for poison exposures was significantly higher in the COVID-19 cohort compared with the pre-COVID-19 cohort (8.4% vs 3.7%, $p < 0.01$). Severity of medical outcomes differed between the groups; the COVID-19 cohort had more extreme clinical presentations of no effect or death ($p < 0.01$). No significant difference was found among the remaining secondary outcomes. Classes of substances ingested were comparable with baseline poison center data.

CONCLUSIONS Poisoning-related PICU admissions occurred at more than twice the pre-pandemic rate. This may emphasize the effect of the COVID-19 pandemic on pediatric access and exposure to poisons.

ABBREVIATIONS ED, emergency department; IRB, institutional review board; NPDS, National Poison Data System; OTC, over-the-counter; PICU, pediatric intensive care unit

KEYWORDS COVID-19; critical care; emergencies; epidemiology; intensive care units; pediatrics; poisons; toxicology

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Introduction

Poison exposures are a common toxicologic emergency in the pediatric population, and frequently require hospitalization.¹ In severe poisonings, patients may require admission to the pediatric intensive care unit (PICU) for close hemodynamic, respiratory, and neurological monitoring. Exposures may be intentional or unintentional, with intentional exposures predominating among adolescents and unintentional among infants and toddlers, but nearly all pediatric exposures have unsupervised access to the substance or substances involved.²

The COVID-19 pandemic was declared a national emergency in the United States in March 2020.³ A statewide shutdown including closing of schools was initiated, which resulted in increased anxiety, depression, and stress in school-aged children and

adolescents.⁴ Analysis of data abstracted from the American Association of Poison Control Centers' National Poison Data System (NPDS) found an absolute decrease in pediatric exposure cases during the pandemic.⁵ However, the effect of the COVID-19 pandemic is still being fully elucidated. Analyses of exposures have identified increases in pediatric emergency room visit rates and total hospital admissions, increased rate of intentional ingestions, and a higher proportion of serious clinical effects in hospitalized adolescents during the pandemic.^{6–8} However, data on PICU admissions for drug exposures are still lacking. The purpose of this study was to compare rates of exposure-related PICU admissions to all-cause PICU admissions, identify any shifts in intentionality, describe the pharmacologic epidemiology of these exposures, and evaluate patient outcomes in

2018–2019 compared with 2020–2021 amidst the COVID-19 pandemic.

Materials and Methods

This was a retrospective cohort study conducted at a tertiary care pediatric institution. Patients were identified from the Indiana poison center's database and the Virtual Pediatric Systems Database (VPS, LLC <http://www.myvps.org/>), an online repository of standardized data sharing from over 200 PICUs. Further patient data were supplemented with hospital medical record information. Patients 18 years of age or younger with a suspected toxicologic exposure reported to the poison center during the specified periods were included. Cases in which a toxicology cause was eventually ruled out were confirmed by manual chart review and excluded. The pre-COVID-19 cohort included patients admitted January 2018, through December 2019, to establish a baseline rate of toxicologic exposures requiring PICU admission immediately prior to the country-wide spread of COVID-19. The COVID-19 cohort included patients admitted from January 2020 through February 2021, which reflects the start of travel restrictions in the United States to the return to full in-person school attendance in Indiana.

The primary outcome was incidence of exposures requiring PICU admission. The proportion of exposure-related PICU admissions to all-cause PICU admissions was compared between the pre-COVID-19 cohort and COVID-19 cohort. Secondary outcomes included medical outcome stratified by severity, PICU length of stay, hospital length of stay, and need for mechanical ventilation. The reason for exposure as well as the ratio of intentional vs unintentional exposures and percentage of patients admitted following a first attempt vs prior attempt were examined.

A simplified version of the NPDS substance classification was used to group products by pharmacologic mechanism. Medical outcomes were categorized as no effect, minor effect, moderate effect, or major effect according to standard NPDS definitions.⁹ Hypothesis tests for frequencies were conducted using χ^2 analyses. All statistics were performed using R studio v.4.0.3 (Vienna, Austria).

Results

A total of 340 patients were included in the study population. The median age among both cohorts was 14.5 (IQR, 11.9–16.1) years and patients were predominantly female. There were no significant demographic differences between the 2 cohorts (Table).

A total of 149 exposure-related PICU admissions occurred in the 24-month period of the pre-COVID-19 cohort, whereas 191 exposure-related PICU admissions occurred in the 14-month period of the COVID-19 cohort. The average all-cause PICU admissions per day were similar at 5.46 per day in the pre-COVID-19

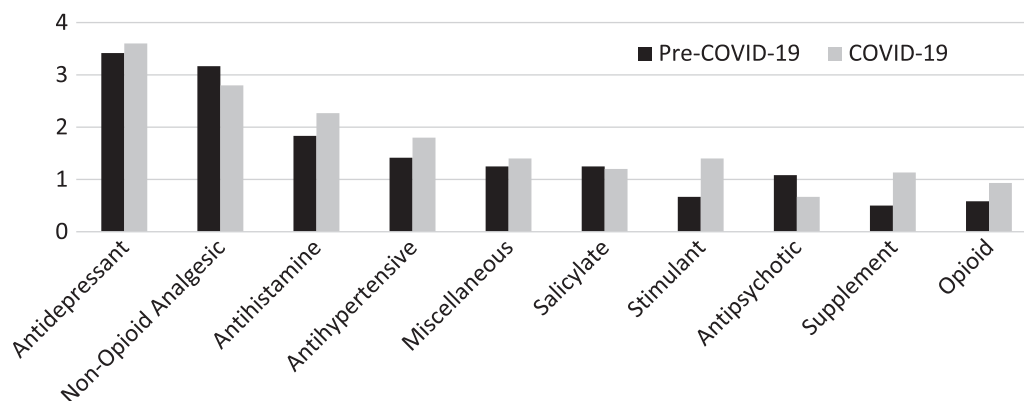
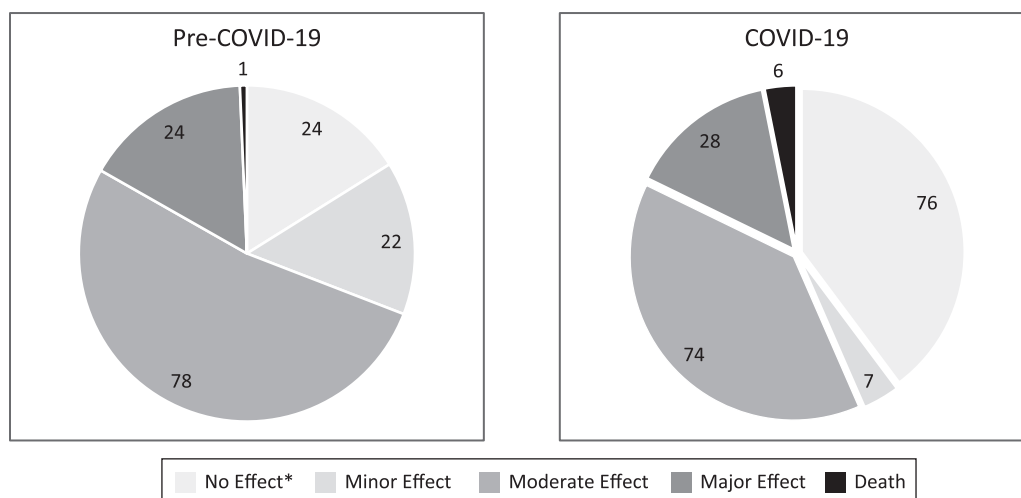
cohort and 5.41 per day in the COVID-19 cohort, while the exposure admissions increased significantly (0.2 vs 0.45 per day, $p < 0.01$). When using exposure-related admissions normalized to all-cause PICU admissions, we found that the rate of exposure-related PICU admissions was significantly higher in the COVID-19 cohort (8.4% vs 3.7%, $p < 0.01$). Prescription medications were more likely to be ingested in comparison with over-the-counter (OTC) medications in both groups (56% vs 57%, $p = 0.20$). Antidepressants were the most common exposure with an average of 3.4 and 3.6 admissions per month in the pre-COVID-19 and COVID-19 cohorts, respectively (Figure 1). Further classes of medications

Table. Patient Characteristics

	Pre-COVID-19 n = 149	COVID-19 n = 191	p
Age (yr)*	14.5 (11.3–15.9)	14.6 (12.0–16.2)	0.82
Male†	44 (30%)	60 (31%)	0.80
Race†			0.95
White	110 (74%)	139 (73%)	
Black	19 (13%)	24 (13%)	
Other	20 (13%)	28 (15%)	
Intubation†	18 (12%)	26 (14%)	0.80
Mechanical ventilation length (days)*	1.5 (0.8–2.1)	1.1 (0.5–1.8)	0.18
PICU length of stay (days)*	1 (0.7–1.6)	1.1 (0.8–1.7)	0.16
Hospital length of stay (days)*	1.8 (1.4–2.7)	2.3 (1.3–3.5)	0.14
Mortality†	1 (1%)	6 (3%)	0.14
Multi-drug exposure†	47 (32%)	58 (30%)	0.95
Drug classification†			0.20
OTC	49 (33%)	52 (27%)	
Rx	69 (46%)	77 (40%)	
OTC and Rx	15 (10%)	33 (17%)	
Unknown	16 (11%)	29 (15%)	
Reason for exposure†			0.80
Intentional suicide attempt	97 (65%)	121 (63%)	
Unintentional accident	36 (19%)	45 (24%)	
Intentional abuse	7 (4%)	14 (7%)	
Unknown	9 (5%)	11 (6%)	
First suicide attempt†	59 (60.2%)	74 (61.7%)	0.99

* Median (IQR).

† N (%).

Figure 1. Admission rate per month by medication class.**Figure 2.** Medical outcomes by severity.

Serious Outcome (Moderate Effect, Major Effect, Death) $p = 0.02$

*No Effect $p < 0.01$

ingested also did not differ between the 2 cohorts and had a comparable distribution to national trends reported to NPDS.

The most common reason for exposure was intentional suicide attempt (63%–65%) followed by unintentional exposure (24%). Among patients admitted for intentional self-harm, the index case was the first attempt for the majority in each group (60.2% vs 61.7%, $p = 0.80$). The overall severity of medical outcomes differed between the 2 cohorts, with more patients presenting with either no effect or death in the COVID-19 cohort ($p < 0.01$) (Figure 2). The pre-COVID-19 cohort had a higher frequency of serious outcomes, defined as a composite outcome of moderate effect, major effect, or death (69% vs 57%, $p = 0.02$), and a lower frequency of no effect (16% vs 40%, $p < 0.01$). There was no difference in PICU length of stay, hospital

length of stay, or need for intubation and mechanical ventilation between cohorts (Table). Independent review was performed by a clinical toxicologist to validate that the cause of death was related to an exposure in all 7 patients who died.

Discussion

This is the first description of the impact of the COVID-19 pandemic on PICU admissions for toxicologic emergencies; however, several previous studies have discussed the impact of COVID-19 on related metrics such as poison center calls, emergency department (ED) visit rates, and hospitalizations in children and adolescents.

Lelak et al⁵ found a 0.5% increase in intentional ingestions despite a 6.3% absolute decrease in ingestion

calls to poison centers concerning the general pediatric population. The authors theorized that more unintentional ingestions may have been triaged to home management to reduce ED burden, a conclusion echoed by Schultz et al⁸ who identified an increase in intentional ingestions among hospitalized pediatric patients. Our study did not demonstrate this same difference in the ratio of intentional vs unintentional ingestions in patients admitted to the PICU, possibly due to our single-center design, small sample size, and the fact that a majority of our patients were admitted with intentional ingestions.

Devlin et al⁶ utilized electronic medical record data and found the rates of poisonings relative to emergency department encounters doubled during the COVID-19 pandemic, while Wang et al⁷ reported an increase in adolescents hospitalized for exposures. One possible explanation for these findings seemingly contrasting the decrease in calls to poison centers Lelak et al⁵ reported is that, while the total number of exposures voluntarily reported to the poison center may have decreased, the severity of the ingestion and need for acute medical services in the emergency department and hospital increased. Our study examining the exposures admitted to the PICU would support this theory, as we found a higher percentage of exposures requiring PICU care in the COVID-19 cohort compared with the pre-COVID-19 cohort.

Wang et al⁷ found a higher likelihood of serious clinical effects in hospitalized adolescents during COVID-19. In contrast, our study found a smaller percent of patients with a serious medical outcome and a larger percent of no clinical effects in the COVID-19-cohort. This finding was similar to the conclusions reached by Schultz et al,⁸ who did not find a difference in clinical effects across the Pediatric Health Information System database. Our finding could be because of our institution's status as a large pediatric referral center. Lack of bed availability and emphasis on ED throughput during times of high overall visit rates at outside institutions may have led to earlier transfers to our institution, resulting in a significant increase in patients admitted with less severe exposures. Our institution was not impacted by bed reallocation during the pandemic and was thus able to preserve resources for pediatric patients with potentially serious poisonings.

There were a number of limitations to our study. First, we were unable to account for factors such as the unregulated and highly variable closure of social and health care resources (including schools and pediatric inpatient beds) by each individual state, nor could we determine the impact of factors such as loss of socialization and prolonged shelter-in-place policies. Second, we selected the years prior to the pandemic being declared a statewide emergency as our baseline, which could introduce bias if these years were

not reflective of this population in general. To best represent the impact of isolation, the COVID-19 cohort time period was when our state government prevented children from being in schools together and limited access to outpatient therapies. Despite the potential impact of the pandemic on routine health care visits, no difference was found in the distribution of drug classification (prescription vs OTC) nor in the most common exposure substances. A third consideration is that the use of a composite outcome for serious events, although common practice in studies of poison center data, has not been validated by NPDS and should be interpreted with due caution.

Conclusion

Pediatric patients with a poison exposure during the COVID-19 pandemic cohort were admitted to our PICU at more than twice the rate of similar exposures pre-COVID-19. Medical outcomes shifted toward the extremes of the spectrum during the pandemic, with more patients experiencing either a serious outcome or no effect from their exposure compared to pre-pandemic. The reasons for exposure and substances ingested were comparable in both cohorts.

Article Information

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Ethical Approval and Informed Consent. Given the nature of this study, institutional review board/ethics committee review and informed consent were not required.

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