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Pandemic-Related Shifts in New Patients Admitted to Children's Hospitals

Nicholas A. Clark, MD,[a,b] Jonathan Rodean, MPP,[c] Marcos Mestre, MD,[d] Hemalatha G. Rangarajan, MD,[e] Margaret Samuels-Kalow, MD, MPhil, MSHP,[f] Prakash Satwani, MD,[g] Joseph R. Stanek, MS,[e] Ian D. Wolfe, PhD, RN,[h] Kenneth A. Michelson, MD, MPH[i]

ABSTRACT

OBJECTIVES: During the coronavirus disease 2019 pandemic, professional organizations recommended preferential transfer of pediatric patients from general hospitals to children's hospitals. Patients previously receiving all care at other facilities would be new to children's hospitals. As a proxy for care consolidation, we sought to describe changes in new patient encounters at children's hospitals and test associations between local severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) incidences and new patient encounters.

METHODS: This retrospective cohort study included patients aged 6 months to 18 years admitted to children's hospitals from March 15, 2019, to June 30, 2019 (control) and 2020 (pandemic period). Primary outcome was odds ratio of being a new versus established patient by study period. Generalized linear models estimated odds of being a new patient with adjustment for diagnosis. Analyses were also stratified by local SARS-CoV-2 transmission.

RESULTS: There were 205 283 encounters (45.3% new patients). New patients were more common in the pandemic period than in the control (46.4 vs 44.7%, OR 1.07, 95% confidence interval [CI]: 1.05 to 1.09). After adjusting for diagnosis, pandemic new patients were no more common than control new patients (adjusted odds ratio 1.00, 95% CI: 0.98 to 1.02). Compared with hospitals experiencing low local SARS-CoV-2 transmission, admission encounters at both medium and high transmission hospitals were more likely to be new (adjusted odds ratio 1.08, 95% CI: 1.03 to 1.14 and 1.09, 95% CI: 1.03 to 1.15, respectively).

CONCLUSIONS: During the early coronavirus disease 2019 pandemic, proportional increases in new patients to children's hospitals appeared to be due to changes in diagnoses but were also associated with local SARS-CoV-2 transmission. Pediatric care consolidation may have occurred; how this may have impacted outcomes for hospitalized children is unclear.

[a]Division of Hospital Medicine, Children's Mercy Kansas City, Kansas City, Missouri; [b]School of Medicine, University of Missouri-Kansas City, Kansas City, Missouri; [c]Children's Hospital Association, Lenexa, Kansas; [d]Division of Hospital Medicine, Department of Pediatrics, Nicklaus Children's Hospital, Miami, Florida; [e]Division of Hematology, Oncology, and Blood and Marrow Transplant, Nationwide Children's Hospital, Columbus, Ohio; [f]Department of Emergency Medicine, Massachusetts General Hospital, Boston, Massachusetts; [g]Department of Pediatrics, Columbia University Irving Medical Center, New York, New York; [h]Clinical Ethics Department, Children's Minnesota, Minneapolis, Minnesota; and [i]Division of Emergency Medicine, Boston Children's Hospital, Boston, Massachusetts

www.hospitalpediatrics.org
DOI:https://doi.org/10.1542/hpeds.2021-005876

Address correspondence to Nicholas A. Clark, MD, Children's Mercy Kansas City, 2401 Gillham Rd, Kansas City, MO 64108. E-mail: nclark1@cmh.edu

HOSPITAL PEDIATRICS (ISSN Numbers: Print, 2154-1663; Online, 2154-1671).

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

COMPANION PAPER: A companion to this article can be found online at www.hosppeds.org/cgi/doi/10.1542/hpeds.2021-006027.

Dr Clark conceptualized and designed the study, participated in interpretation of data, drafted the initial manuscript, and reviewed and revised the manuscript; Dr Michelson assisted with conceptualization and design of the study, assisted with interpretation of data, and reviewed and revised the manuscript; Mr Rodean assisted with conceptualization and design of the study, conducted statistical analyses and interpretation of the data, and reviewed and revised the manuscript; Drs Mestre, Rangarajan, Samuels-Kalow, Satwani, and Wolfe and Mr Stanek provided critical input on study design, assisted with interpretation of data, and reviewed and revised the manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), its associated coronavirus disease 2019 (COVID-19) illness, and the subsequent pandemic have disproportionately impacted adults, with only 1.7% to 9.1% of documented cases occurring in patients <18 years of age.[1,2] Some general hospitals (facilities caring for adult patients with or without a dedicated pediatric unit) experiencing COVID-19 case surges have needed to expand bed capacity quickly.[3] In response, the Children's Hospital Association, American Academy of Pediatrics, and the Association of American Medical Colleges provided recommendations in which initial efforts should be aimed at preferentially transferring children (<18 years of age) requiring inpatient care from general hospitals to children's hospitals. These transfers would thereby improve hospital capacity for adult patients at general hospitals.[4,5] Because the United States experienced several waves of worsening, widespread transmission of SARS-CoV-2 and subsequent limitations on adult bed availability and resources at general hospitals, understanding how children's hospitals supported an already strained health care system by means of assuming care of additional pediatric patients is of importance.

Preferential transfers to children's hospitals would also be in keeping with recent trends toward regionalization of pediatric care to centers with greater pediatric capabilities, such as academic centers.[6,7] Children who previously received care in community hospitals would be new to these regionalized centers. Therefore, shifts in regionalization, particularly during a pandemic, are measurable as an increase in the proportion of new patients to a hospital. In other words, pediatric patients previously receiving care at non–children's hospitals may be transferred or deferred to children's hospitals, thereby being new to children's hospitals.

In our study, we aimed to describe consolidation of pediatric care to children's hospitals during a 10-week period during the early COVID-19 pandemic. We hypothesized that this period during the pandemic would be associated with a relative increase in new patient (as opposed to established patient) encounters compared with a control prepandemic period. Our study had 2 additional objectives: (1) to assess patient and hospital characteristics associated with new patient encounters during the early COVID-19 pandemic and (2) to test associations between local SARS-CoV-2 cumulative incidences and changes in new patient encounters.

METHODS

Data Source

This retrospective cohort study used the Pediatric Health Information System (PHIS). PHIS is an administrative database maintained by the Children's Hospital Association (Lenexa, KS). PHIS contains demographics data, discharge and procedural codes, and billing data from 50 tertiary care US children's hospitals. Patients are assigned a unique, encrypted identifier to allow for tracking a patient across multiple encounters. PHIS hospitals that did not contribute data for each of the years 2016–2019 were excluded because we were unable to ascertain whether patients had previous encounters.

Study Population

This study included admission (inpatient and observation) encounters for patients 6 months to 18 years of age from March 15, 2019, to June 30, 2019 (control period) and March 15, 2020, to June 30, 2020 (pandemic period). March 15 was chosen because this was the Sunday of the week coinciding with initiation of the first statewide pandemic stay-at-home order,[8] and internal analysis of PHIS data found reductions in inpatient volumes starting on this date. Patients <6 months of age were excluded because such patients were unlikely to experience the main outcome measure, owing to their age. Maternal care encounters were also excluded because of the variability with which children's hospitals generally provide maternal care.

Measures

Outcomes

The primary outcome was the change in odds of a new patient admission encounter between study periods, a surrogate for changes in referral patterns. New patient encounters were defined as an encounter by a patient who has not had any previous emergency department (ED) or admission encounters at the facility within the previous 3 years.[9] For example, for a patient admitted on February 2, 2020, the 3-year lookback window would be February 2, 2017, to February 1, 2020. Each unique patient received 1 designation per study period; for instance, a new patient who had 3 encounters during the pandemic period was considered to be a new patient for all 3. All non–new patient encounters were treated as established patient encounters. A sensitivity analysis was also conducted such that only the initial encounter for each patient during a given study period was counted. In other words, this subsequent analysis excluded repeat encounters by the same patient during a given study period.

Variables

The main exposure was time period, defined as control versus pandemic period. Patient-level characteristics included the following: age, sex, race and ethnicity, insurance payer type (public or private), median zip code income above the federal poverty level, primary discharge diagnosis (categorized by using the admission All Patients Refined Diagnosis Related Group [APR-DRG]), history of a complex chronic condition (CCC),[10] and distance traveled to seek care. Distance traveled to seek care was determined as geodetic distance from the centroid of the patient's home zip code to the centroid of the hospital zip code. We also examined admission source (own ED, inbound transfer, or direct admission), occurrence of an operating room procedure as defined by Centers for Medicare and Medicaid procedural codes, and billing of an ICU stay. US Census Bureau geographic region (Northeast, Midwest, South, and West) served as a hospital-level characteristic. Patient-level severity of illness was calculated as defined by the Hospitalization Resource Intensity Score for Kids (H-RISK).[11] An H-RISK value of 1 is equivalent to a pediatric admission of average cost.

Analysis

Distributions of encounter and hospital characteristics were reported by study period, and risk differences with corresponding 95% confidence intervals (CIs) were calculated. Odds ratios (ORs) with corresponding 95% CIs were also calculated to test the relative frequency of new patient encounters during the control versus pandemic period. Generalized linear models with a random intercept for hospitals were used to assess how potential confounders could alter the relationship between the pandemic and proportion of new patients. Covariates included potential confounders of the relationship between study period and new patient admission encounters: age, sex, race, and/or ethnicity, payer, median zip code income above the federal poverty level, CCC, admission source, occurrence of an operating room procedure, and billing of an ICU stay. Two adjusted models were created: one with condition (the encounter APR-DRG) and one without.

Local SARS-CoV-2 Cumulative Incidence and Change in New Patient Encounters

To evaluate the impact local SARS-CoV-2 transmission had on new patient admissions during the pandemic, we investigated the association between local SARS-CoV-2 cumulative incidence in each hospital's county and change in odds of a new patient admission between study periods. A hospital's local SARS-CoV-2 cumulative incidence was determined by using data for the county where a hospital was located. Local cumulative incidences were calculated by using a county's June 30, 2020 cumulative number of SARS-CoV-2 cases per 100 000 population. County cases and population counts were obtained from USAFacts.org, a data supplier to the Centers for Disease Control and Prevention.[12] K-means clustering was performed to categorize hospitals into low (<680 cases per 100 000), medium (681–1128), and high (>1128) SARS-CoV-2 transmission counties. This clustering strategy helps ensure hospitals that are experiencing similar cumulative incidences are grouped together. Cumulative incidence level was then included as a main effect and interaction effect in the models with the pandemic period to calculate the relative change in odds between the 3 groups. Adjusted odds ratios (aORs) were calculated for likelihood of experiencing a new patient encounter by K-means clustering category (low, medium, high) by using the previously described model that included adjustment for patient and hospital characteristics as well as condition (APR-DRG). A concept diagram displaying pandemic-related pressures for pediatric care consolidation to children's versus general hospitals can be found in Supplemental Fig 2. A sensitivity analysis was also conducted for local SARS-CoV-2 cumulative incidences such that only the initial encounter for each patient during a given study period was counted.

Categorical variables were summarized by using frequencies and percentages and compared between periods by using Pearson χ^2 tests. Continuous variables were summarized as medians with interquartile ranges (IQRs); and compared by using Wilcoxon rank tests. Study results were analyzed by using SAS v 9.4 (SAS Institute, Inc, Cary, NC). *P* values <.05 were considered statistically significant. This study was deemed as non–human subjects research by the local office of research integrity.

RESULTS

Across 44 PHIS hospitals, there were 205 283 admission encounters from 173 175 unique patients included in our study. Pandemic admission volumes were 51.9% of control volumes (70 142 vs 135 141, respectively). Overall, most encounters were among patients who were male (52.7%), had public insurance (55.3%), did not have a CCC (59.1%), were admitted from their own ED (56%), did not undergo an operating room procedure (79.7%), and did not require ICU care (87.6%). The median H-RISK score was 1.09 (IQR: 0.72 to 1.84). Compared with all control period admissions, pandemic admissions, overall, had notable increases of being 13 to 18 years of age, driving >20 miles to seek care, undergoing an operating room procedure, and being admitted to a children's hospital in the West. Pandemic patients also had notable decreases of being 1 to 5 years of age, having no CCC, and being admitted to a Midwest children's hospital compared with the control period (Table 1).

Differences in New Patient Encounters

New patient encounters comprised 93 010 (45.3%) of all admissions across both study periods. New patients differed from established patients across study periods for all characteristics investigated except for patient sex (Supplemental Table 5). Pandemic new patients differed modestly from control period new patients. Compared with new patient admissions in the control period, pandemic new patient admissions had notable increases of being 13 to 18 years of age, admitted from a hospital's own ED, undergoing an operating room procedure, and being admitted to a children's hospital in the West. Pandemic new patients also had notable decreases of being 1 to 5 years of age, having no CCC, being a direct admission, and being admitted to a Midwest children's hospital compared with the control period (Table 2).

An admission encounter was also more likely to be a new patient during the pandemic compared with the control period (46.4% vs 44.7%, respectively; OR 1.07, 95% CI: 1.05 to 1.09), and this remained stable after adjusting for patient and hospital characteristics (aOR 1.08, 95% CI: 1.05 to 1.1). However, after accounting for discharge diagnosis (APR-DRG), the frequency of new patient encounters did not differ between study periods (aOR 1.00, 95% CI: 0.98 to 1.02) (Table 3).

TABLE 1 Patient and Hospital Characteristics Stratified by Study Period

	Total	Control (2019)	Pandemic (2020)	Risk Difference, % (95% CI)
n, total	205 283	135 141	70 142	—
Age group, *n* (%)				
6 mo to 1 y	15 423 (7.5)	10 297 (7.6)	5126 (7.3)	−0.3 (−0.6 to −0.1)
1–5 y	71 688 (34.9)	49 622 (36.7)	22 066 (31.5)	−5.3 (−5.7 to −4.8)
6–12 y	59 997 (29.2)	39 547 (29.3)	20 450 (29.2)	−0.1 (−0.5 to 0.3)[a]
13–18 y	58 175 (28.3)	35 675 (26.4)	22 500 (32.1)	5.7 (5.3 to 6.1)
Sex, *n* (%)				
Female	97 101 (47.3)	63 352 (46.9)	33 749 (48.1)	1.2 (0.8 to 1.7)
Race and ethnicity, *n* (%)				
Non-Hispanic white	98 257 (47.9)	63 876 (47.3)	34 381 (49.0)	1.8 (1.3 to 2.2)
Non-Hispanic African American	39 553 (19.3)	26 882 (19.9)	12 671 (18.1)	−1.8 (−2.2 to −1.5)
Hispanic	42 313 (20.6)	27 692 (20.5)	14 621 (20.8)	0.4 (0 to 0.7)[a]
Other	25 160 (12.3)	16 691 (12.4)	8469 (12.1)	−0.3 (−0.6 to 0)[a]
Payer, *n* (%)				
Public	110 977 (55.3)	73 752 (55.7)	37 225 (54.6)	−1.5 (−2 to −1)
Private	81 535 (40.6)	53 526 (40.4)	28 009 (41.1)	0.3 (−0.1 to 0.8)[a]
Other	8120 (4.0)	5128 (3.9)	2 992 (4.4)	0.5 (0.3 to 0.7)
Zip code income percentage of poverty guideline, *n* (%)				
<150%	45 206 (22.0)	29 716 (22.0)	15 490 (22.1)	0.1 (−0.3 to 0.5)[a]
150–199%	61 979 (30.2)	40 994 (30.3)	20 985 (29.9)	−0.4 (−0.8 to 0)[a]
200–249%	42 241 (20.6)	27 758 (20.5)	14 483 (20.6)	0.1 (−0.3 to 0.5)[a]
250%+	50 812 (24.8)	33 515 (24.8)	17 297 (24.7)	−0.1 (−0.5 to 0.3)[a]
Missing	5045 (2.5)	3158 (2.3)	1887 (2.7)	0.4 (0.2 to 0.5)
CCCs, *n* (%)				
None	121 365 (59.1)	81 902 (60.6)	39 463 (56.3)	−4.3 (−4.8 to −3.9)
1	49 635 (24.2)	31 602 (23.4)	18 033 (25.7)	2.3 (1.9 to 2.7)
2	20 951 (10.2)	13 209 (9.8)	7742 (11.0)	1.3 (1 to 1.5)
3+	13 332 (6.5)	8428 (6.2)	4904 (7.0)	0.8 (0.5 to 1)
Distance traveled to seek care, *n* (%)				
<5 miles	25 072 (12.2)	17 127 (12.7)	7945 (11.3)	−1.3 (−1.6 to −1.1)
5–10 miles	37 464 (18.2)	25 225 (18.7)	12 239 (17.4)	−1.2 (−1.6 to −0.9)
10–20 miles	48 994 (23.9)	32 323 (23.9)	16 671 (23.8)	−0.2 (−0.5 to 0.2)[a]
>20 miles	93 018 (45.3)	59 952 (44.4)	33 066 (47.1)	2.8 (2.3 to 3.2)
Missing	735 (0.4)	514 (0.4)	221 (0.3)	−0.1 (−0.1 to 0)[a]
Admission source, *n* (%)				
Own ED	114 976 (56.0)	75 760 (56.1)	39 216 (55.9)	−0.1 (−0.6 to 0.3)[a]
Inbound transfer	27 224 (13.3)	17 760 (13.2)	9448 (13.5)	0.3 (0 to 0.6)[a]
Direct admission	63 083 (30.7)	41 605 (30.8)	21 478 (30.6)	−0.2 (−0.6 to 0.3)[a]
Operating room procedure, *n* (%)	41 580 (20.3)	25 694 (19.0)	15 886 (22.6)	3.6 (3.3 to 4)
ICU stay	25 475 (12.4)	16 267 (12.0)	9208 (13.1)	1.1 (0.8 to 1.4)
Hospital region, *n* (%)				
Midwest	56 297 (27.4)	38 509 (28.5)	17 788 (25.4)	−3.1 (−3.5 to −2.7)
Northeast	24 583 (12.0)	16 621 (12.3)	7962 (11.4)	−0.9 (−1.2 to −0.7)
South	84 480 (41.2)	55 039 (40.7)	29 441 (42.0)	1.2 (0.8 to 1.7)
West	39 923 (19.4)	24 972 (18.5)	14 951 (21.3)	2.8 (2.5 to 3.2)
H-RISK, median (IQR)	1.09 (0.72 to 1.84)	1.03 (0.68 to 1.70)	1.20 (0.73 to 2.01)	—

All P values < .001, except admission source (P = .13). —, not applicable.
[a] CI includes 0.

In our sensitivity analysis, in which repeat encounters during the same study period were excluded, similar results were found. Admission encounters were more likely to be a new patient during the pandemic compared with the control period (OR 1.09, 95% CI: 1.07 to 1.12), and was stable after adjusting for patient and hospital characteristics (aOR 1.08, 95% CI: 1.06 to 1.11). Again, after accounting for patient and hospital characteristics along with condition, there was no difference between study periods (aOR 0.99, 95% CI: 0.97 to 1.02).

The 10 most common discharge diagnoses differed between study periods, with seizure being the most common diagnosis in both study periods (4.8% control versus 4.7% pandemic). However, diagnoses often attributed to or exacerbated by viral illness (asthma, other gastroenteritis, nausea and vomiting, and infections of the upper respiratory tract) were 3 of the top 10 diagnoses in the control period (9.6% combined) and none in the pandemic period. Surgical procedures were 3 of the top 10 diagnoses in the control period (9.7%) vs 4 in the pandemic period (12.9%) (Table 4).

Local SARS-CoV-2 Transmission and Change in New Patient Encounters

Eighteen hospitals (40.9%) were categorized as having low, 13 (29.5%) were classified as having medium, and 13 (29.5%) as having high local SARS-CoV-2 transmission. aORs of being a new patient in the pandemic compared with control period, stratified by transmission category, ranged from 0.68 to 1.19 (Fig 1). Both medium and high transmission area hospitals were at increased odds of experiencing a new patient encounter during the pandemic when compared with those categorized as low (medium versus low aOR 1.08, 95% CI: 1.03 to 1.14; high versus low aOR 1.09, 95% CI: 1.03 to 1.15).

In our sensitivity analysis, in which repeat encounters during the same study period were excluded, similar results were also found. Both medium and high transmission area hospitals were still at increased odds of experiencing a new patient encounter during the pandemic when compared with those categorized as low (medium versus low aOR 1.11, 95% CI: 1.05 to 1.17; high versus low aOR 1.1, 95% CI: 1.03 to 1.16).

DISCUSSION

Although overall admission volumes at children's hospitals were significantly lower during the early COVID-19 pandemic, new patient admissions were relatively more common during the early COVID-19 pandemic than in early 2019. This difference was small and shifts in diagnoses appeared to account for the entirety of the difference. However, hospitals experiencing medium and high local SARS-CoV-2 transmission were at increased odds of experiencing new patient admission encounters over hospitals with low local transmission, suggesting a component of pediatric care consolidation may have occurred at the county level in response to increases in SARS-CoV-2 cases. If increases in new patient admissions were indeed attributable to changes in diagnoses but also associated with increases in local SARS-CoV-2 transmission, it would suggest that communities were consolidating some pediatric inpatient care to children's hospitals in response to needs at adult hospitals. Although a component of consolidation appears to have occurred, it was small and opportunities may still exist to further consolidate pediatric care to children's hospitals during the pandemic. This would be particularly important during periods of worsening, widespread SARS-CoV-2 transmission when limitations on bed availability at general hospitals may exist.[13] When pediatric inpatient volumes are low, children's hospitals may be able to fill the role of primary centers of pediatric and young adult care for communities experiencing SARS-CoV-2 case surges, thereby increasing general hospital bed availability.

Areas of the country with SARS-CoV-2 case surges have experienced higher volumes of adult cases than pediatric cases. In areas where inpatient beds have been unavailable, patients have received care in unlicensed treatment spaces or required transfer.[3] Ceasing pediatric inpatient operations at general hospitals during a surge and shifting these patients to children's hospitals would allow general hospitals to reserve remaining licensed beds for adult patients, allow for expanded bed capacity through conversion of existing pediatric units to adult beds, and ensure conservation of critical resources (eg, ventilators) for adults at high risk for severe COVID-19 illness. Given calls to action by national pediatric medical organizations to regionalize care[4,5] and that nearly all children's hospitals included in our study were located in a hot spot county during our pandemic study period,[14] we anticipated a greater degree of consolidation to have taken place. That being said, it was reassuring to see that a degree of pediatric care consolidation, at least in terms of new patient admission encounters, may have occurred in response to increasing local transmission (Fig 1). Although our findings may suggest changes were related to local SARS-CoV-2 transmission, our analyses are unable to account for local and regional disaster preparedness practices that may have impacted our results.[15] Because the United States experienced more widespread transmission after our study window,[13] it will be important to reevaluate our findings by comparing pediatric care consolidation within and across subsequent time periods of the pandemic.

We found an overall reduction in pediatric hospitalizations (Table 1) and proportionally fewer viral infection-related diagnoses during the pandemic period (Table 4), both of which support recent literature.[16,17] Our findings expand on previous studies that were conducted at a single center with smaller sample sizes because our work includes a more robust patient sample from multiple children's hospitals across the United States. Viral illnesses impact both healthy children and those with chronic conditions who may be either new or established, yet a smaller proportion of patients admitted for viral illnesses have comorbid or chronic conditions.[18,19] With less contact occurring

TABLE 2 Patient and Hospital Characteristics Stratified by Encounter Type and Then by Study Period

	New Patient Admission Encounters			Established Patient Admission Encounters		
	Control (2019)	Pandemic (2020)	Risk Difference, % (95% CI)	Control (2019)	Pandemic (2020)	Risk Difference, % (95% CI)
n, total	60 448	32 562	—	74 693	37 580	—
Age group, *n* (%)						
6 mo to 1 y	4 633 (7.7)	2299 (7.1)	−0.6 (−1 to −0.3)	9913 (12.3)	5253 (13.0)	0.7 (0.3 to 1.1)
1–5 y	19 577 (32.4)	9022 (27.7)	−4.7 (−5.3 to −4.1)	30 518 (38.0)	13 066 (32.3)	−6.1 (−6.7 to −5.5)
6–12 y	19 012 (31.5)	10 282 (31.6)	0.1 (−0.5 to 0.8)[a]	20 879 (26.0)	10 178 (25.2)	−0.9 (−1.4 to −0.3)
13–18 y	17 226 (28.5)	10 959 (33.7)	5.2 (4.5 to 5.8)	18 656 (23.2)	11 554 (28.6)	5.8 (5.2 to 6.3)
Sex, *n* (%)						
Female	28 495 (47.1)	15 507 (47.6)	0.5 (−0.2 to 1.2)[a]	34 857 (46.7)	18 242 (48.5)	1.9 (1.3 to 2.5)
Race and ethnicity, *n* (%)						
Non-Hispanic white	31 035 (51.3)	17 058 (52.4)	1 (0.4 to 1.7)	32 841 (44.0)	17 323 (46.1)	2.1 (1.5 to 2.7)
Non-Hispanic African American	9217 (15.2)	4615 (14.2)	−1.1 (−1.5 to −0.6)	17 665 (23.7)	8056 (21.4)	−2.2 (−2.7 to −1.7)
Hispanic	11 499 (19.0)	6275 (19.3)	0.2 (−.03 to 0.8)[a]	16 193 (21.7)	8346 (22.2)	0.5 (0 to 1)[a]
Other	8697 (14.4)	4614 (14.2)	−0.2 (−0.7 to 0.3)[a]	7994 (10.7)	3855 (10.3)	−0.4 (−0.8 to −0.1)
Payer, *n* (%)						
Public	28 693 (48.5)	15 044 (47.6)	−1.3 (−1.9 to −0.6)	45 059 (61.5)	22 181 (60.6)	−1.3 (−1.9 to −0.7)
Private	27 428 (46.4)	14 622 (46.3)	−0.5 (−1.1 to 0.2)[a]	26 098 (35.6)	13 387 (36.6)	0.7 (0.1 to 1.3)
Other	3005 (5.1)	1936 (6.1)	1 (0.7 to 1.3)	2123 (2.9)	1056 (2.9)	0 (−0.2 to 0.2)[a]
Zip code income percentage of poverty guideline, *n* (%)						
<150%	11 986 (19.8)	6568 (20.2)	0.3 (−0.2 to 0.9)[a]	17 730 (23.7)	8922 (23.7)	0 (−0.5 to 0.5)[a]
150–199%	17 768 (29.4)	9510 (29.2)	−0.2 (−0.8 to 0.4)[a]	23 226 (31.1)	11 475 (30.5)	−0.6 (−1.1 to 0)[a]
200–249%	12 457 (20.6)	6692 (20.6)	−0.1 (−0.6 to 0.5)[a]	15 301 (20.5)	7791 (20.7)	0.2 (−0.3 to 0.7)[a]
250%+	16 573 (27.4)	8781 (27.0)	−0.4 (−1 to 0.1)[a]	16 942 (22.7)	8516 (22.7)	0 (−0.5 to 0.5)[a]
Missing	1664 (2.8)	1011 (3.1)	0.4 (0.1 to 0.6)	1494 (2.0)	876 (2.3)	0.3 (0.1 to 0.5)
CCCs, *n* (%)						
None	46 322 (76.6)	24 072 (73.9)	−2.7 (−3.3 to −2.1)	35 580 (47.6)	15 391 (41.0)	−6.7 (−7.3 to −6.1)
1	10 418 (17.2)	6070 (18.6)	1.4 (0.9 to 1.9)	21 184 (28.4)	11 963 (31.8)	3.5 (2.9 to 4)
2	2667 (4.4)	1729 (5.3)	0.9 (0.6 to 1.2)	10 542 (14.1)	6013 (16.0)	1.9 (1.4 to 2.3)
3+	1041 (1.7)	691 (2.1)	0.4 (0.2 to 0.6)	7387 (9.9)	4213 (11.2)	1.3 (0.9 to 1.7)
Distance traveled to seek care, *n* (%)						
<5 miles	5097 (8.4)	2547 (7.8)	−0.6 (−1 to −0.2)	12 030 (16.1)	5398 (14.4)	−1.7 (−2.2 to −1.3)
5–10 miles	9268 (15.3)	4798 (14.7)	−0.6 (−1.1 to −0.1)	15 957 (21.4)	7441 (19.8)	−1.6 (−2.1 to −1.1)
10–20 miles	14 648 (24.2)	7793 (23.9)	−0.3 (−0.9 to 0.3)[a]	17 675 (23.7)	8878 (23.6)	0 (−0.6 to 0.5)[a]
>20 miles	31 145 (51.5)	17 319 (53.2)	1.7 (1 to 2.3)	28 807 (38.6)	15 747 (41.9)	3.3 (2.7 to 3.9)
Missing	290 (0.5)	105 (0.3)	−0.2 (−0.2 to −0.1)	224 (0.3)	116 (0.3)	0 (−0.1 to 0.1)[a]
Admission source, *n* (%)						
Own ED	31 699 (52.4)	18 138 (55.7)	3.3 (2.6 to 3.9)	44 061 (59.0)	21 078 (56.1)	−2.9 (−3.5 to −2.3)
Inbound transfer	12 083 (20.0)	6698 (20.6)	0.6 (0 to 1.1[a]	5693 (7.6)	2750 (7.3)	−0.3 (−0.6 to 0)[a]
Direct admission	16 666 (27.6)	7726 (23.7)	−3.8 (−4.4 to −3.3)	24 939 (33.4)	13 752 (36.6)	3.2 (2.6 to 3.8)

TABLE 2 Continued

	New Patient Admission Encounters			Established Patient Admission Encounters		
	Control (2019)	Pandemic (2020)	Risk Difference, % (95% CI)	Control (2019)	Pandemic (2020)	Risk Difference, % (95% CI)
Operating room procedure, *n* (%)	13 889 (23.0)	8996 (27.6)	4.6 (4 to 5.2)	11 805 (15.8)	6890 (18.3)	2.5 (2.1 to 3)
ICU stay, *n* (%)	6739 (11.1)	4091 (12.6)	1.4 (1 to 1.9)	9528 (12.8)	5117 (13.6)	0.9 (0.4 to 1.3)
Hospital region, *n* (%)						
Midwest	15 872 (26.3)	7380 (22.7)	−3.6 (−4.2 to −3)	22 637 (30.3)	10 408 (27.7)	−2.6 (−3.2 to −2.1)
Northeast	6993 (11.6)	3596 (11.0)	−0.5 (−1 to −0.1)	9628 (12.9)	4366 (11.6)	−1.3 (−1.7 to −0.9)
South	26 161 (43.3)	14 434 (44.3)	1 (0.4 to 1.7)	28 878 (38.7)	15 007 (39.9)	1.3 (0.7 to 1.9)
West	11 422 (18.9)	7152 (22.0)	3.1 (2.5 to 3.6)	13 550 (18.1)	7799 (20.8)	2.6 (2.1 to 3.1)
H-RISK, median (IQR)	0.91 (0.63 to 1.57)	1.02 (0.68 to 1.84)	—	1.14 (0.72 to 1.97)	1.24 (0.77 to 2.28)	—

All *P* values < .001, except new patient female sex (*P* = .353), new patient zip code income (*P* = .016), established patient payer (*P* = .009), and established patient zip code income (*P* = .003). —, not applicable.
[a] CI includes 0.

between children as a result of masking and physical distancing recommendations, school and day care closures, increased awareness of proper hand hygiene practices, and stay-at-home orders enacted in many communities, opportunities to spread and contract viral illnesses have decreased.[17] Because our study had a high proportion of new patient admissions without a CCC, and because efforts to curb spread of COVID-19 would also limit spread of other viruses, it was not surprising to see a pandemic-related shift toward fewer new patient admissions with viral infection-related diagnoses.

Efforts were also aimed at managing patients in their home rather than risking potential SARS-CoV-2 exposure in health care settings. Adult centers triaged and canceled elective surgeries,[20] which was mirrored in children's hospitals (eg, reduction in pandemic tonsil and adenoid procedures with a proportional increase in appendectomy diagnoses) (Table 4). Our findings also mimic, strengthen, and expand on results of a recent single center study that examined a similar time period and found an increase in perforated appendicitis cases.[21] Because patient diagnosis eliminated this effect, diagnoses that were relatively more frequent during the pandemic were those that occurred less often during the control period. Diagnoses more prominent in pandemic new patients (eg, appendectomy, upper arm procedures, poisoning of medicinal agents, and cellulitis) are more acute and sporadic in nature rather than chronic and recurrent and, therefore, would result in a decreased likelihood of experiencing a previous ED or admission encounter. However, shifts in top nonviral diagnoses may be related more so to base rates and incidence of disease in which the routine cadence of children presenting with these diagnoses may be a stronger driver of encounters than changes resulting from the pandemic itself.

There are important limitations to consider in setting of our results. First, our study is retrospective in design and reliant on accurate administrative and billing data. Second, we only analyzed a 10-week period early in the pandemic and recommendations to consolidate pediatric care were released 3 weeks into our 10-week study window; with more lead time and/or higher rates of local transmission, regions may have adopted recommendations to consolidate care later in the pandemic. We plan to follow-up on these results as the pandemic unfolds and as new data are made available within PHIS. Third, we used the PHIS database that mostly includes large pediatric academic institutions and does not represent the entire landscape of regional pediatric centers. Other databases, which encompass a wider array of hospitals, were not used because of significantly longer lag times between patient encounters and public availability of data. Fourth, baseline preparedness varies by region and is difficult to measure. Thus, we were unable to determine its contribution to regional differences in new patient encounters. Lastly, we used changes in encounters to serve as a proxy for regionalization. Although no standard exists to directly measure regionalization, in previous pediatric studies, researchers also examined changes in encounter volumes over time to infer regionalization of care.[6,7,22,23]

TABLE 3 Odds of Being a New Patient

Study Period	Unadjusted OR (95% CI)	Without APR-DRG, aOR (95% CI)	With APR-DRG, aOR (95% CI)
Control (2019)	Reference	Reference	References
Pandemic (2020)	1.07 (1.05 to 1.09)	1.08 (1.05 to 1.1)	1.00 (0.98 to 1.02)

CONCLUSIONS

During a 10-week period in the early COVID-19 pandemic, changes in the types of illnesses children were admitted for

TABLE 4 Top 10 New Patient Diagnoses Stratified by Study Period in Rank Order

Control (2019)	*n* (%)	Pandemic (2020)	*n* (%)
Total	19 361 (32.0)	Total	10 141 (31.1)
Seizure	2891 (4.8)	Seizure	1522 (4.7)
Asthma	2194 (3.6)	Appendectomy without complex principal diagnosis[a]	1499 (4.6)
Tonsil and adenoid procedures[a]	2140 (3.5)	Diabetes	1396 (4.3)
Appendectomy without complex principal diagnosis[a]	1997 (3.3)	Shoulder, upper arm, and forearm procedures except join replacement[a]	1060 (3.3)
Other gastroenteritis, nausea, and vomiting	1863 (3.1)	Appendectomy with complex principal diagnosis[a]	1025 (3.1)
Infections of the upper respiratory tract	1746 (2.9)	Other digestive system diagnoses	934 (2.9)
Shoulder, upper arm, and forearm procedures, except joint replacement[a]	1734 (2.9)	Poisoning of medicinal agents	878 (2.7)
Pneumonia, not elsewhere classified	1669 (2.8)	Cellulitis and other skin infections	643 (2.0)
Diabetes	1574 (2.6)	Tonsil and adenoid procedures[a]	618 (1.9)
Other digestive system diagnoses	1553 (2.6)	Pneumonia, not elsewhere classified	566 (1.7)

[a] Surgical procedure.

accounted for a small increase in new patients admitted to children's hospitals. We found some evidence of consolidation of care to children's hospitals related to local SARS-CoV-2 transmission, suggesting that limited consolidation may have occurred in response to the pandemic but that opportunities likely exist to further consolidate pediatric care to maximize adult bed availability within general hospitals.

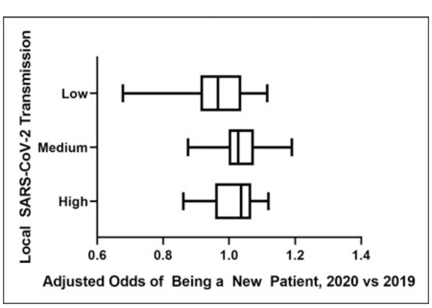

FIGURE 1 Hospital-level adjusted odds of a new patient admission encounter: box and whisker plot comparing hospital-level aORs of being a new patient in the pandemic stratified by local SARS-CoV-2 transmission category. The graph details the aOR median, IQR (box), and value range minimum and maximum (whiskers).

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Nicholas A. Clark, Jonathan Rodean, Marcos Mestre, Hemalatha G. Rangarajan, Margaret Samuels-Kalow, Prakash Satwani, Joseph R. Stanek, Ian D. Wolfe and Kenneth A. Michelson

Hospital Pediatrics originally published online June 1, 2021; originally published online June 1, 2021;